US Army Corps
of Engineers
Savannah District

Pope Air Force Base
North Carolina

Invitation for Bid
DACA21-98-B-0034
Repair Railcar Offload/Transfer Pumps
LI TMKH986001 A/B
Repair Truck Offload/Receipt Pumps
LI TMKH976004 A/B
Volume II of III
Repair Railcar Offload/Transfer Pumps
Technical Provisions - Divisions 2 through 16
May 1998

THIS SOLICITATION IS UNRESTRICTED PURSUANT TO THE "BUSINESS OPPORTUNITY DEVELOPMENT REFORM ACT OF 1988" (PUBLIC LAW 100-656)

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
100 WEST OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3640

Invitation Number
DACA21-98-B-0034

DESCRIPTION/SPECIFICATIONS

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VOLUME II

REPAIR RAILCAR OFFLOAD/TRANSFER PUMPS

April 1988

ZERO ACCIDENTS

SECTION 02072
REMOVAL AND DISPOSITION OF MATERIALS
AND EQUIPMENT FROM EXISTING FACILITIES

INDEX

1. GENERAL. This section covers the preparation for removal and the removal from the existing piping and equipment of all types including electrical and mechanical items attached to or part of such construction and the subsequent disposal of such removal materials and equipment, as noted on the drawings or otherwise specified to be removed. The procedures to be used shall provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The various classifications of removed materials are defined as follows:

1..1. REINSTALLED items are those items which, after removal, are to be reused, reinserted, remounted or otherwise built back into the work under this contract.

1..2. SALVAGED items are those items which, after removal, are to be retained by the Government and delivered for storage on Government premises.

1..3. SCRAPPED items are all other removed materials or equipment. This includes all items which are not noted or specified for reinstallation or salvage.

1..4. SUBMITTALS Submit the following in accordance with Section \=01330=\, "Submittals."

1..4..1. *SD-08, Statements*

a. *Site safety and health plan*; *GA*

b. *Excavation and material handling plan*; *GA*

c. *Field sampling and laboratory testing plan*; *GA*

d. * Piping removal and disposal plan*; *GA*

e. *Qualification*; *GA*

f. *Spill and discharge control plan*; *GA*

1..4..1..1. *Site Safety and Health Plan*; *GA*

Describe safety and health plan and procedures as related to piping and associated equipment removal, and as related to operations associated with petroleum contaminated soils and water. Furnish the name and qualifications

based on education, training, and work experience of the proposed Site Safety and Health Officer.

1..4..1..2. *Excavation and Material Handling Plan* *GA*

Describe methods, means, equipment, sequence of operations and schedule to be employed in excavation, transport, handling, and stockpiling of soil during excavation. Fifteen days before beginning removal work, submit to the Contracting Officer for approval a material handling plan that describes phases of dealing with the contaminated soil and water as it relates to the proposed excavations, including methods of excavating, a material handling plan for the contaminated material, soil testing requirements and safety precautions and requirements.

1..4..1..3. *Field Sampling and Laboratory Testing Plan* *GA*

Describe field sampling methods and quality control procedures. Identify laboratory and laboratory methods to be used for contaminated soil testing. Sample reports shall show sample identification for location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, and quality control procedures.

1..4..1..4. * PipingRemoval and Disposal Plan* *GA*

Describe methods, means, sequence of operations, and schedule to be employed in the testing, pumping, cleaning, de-vaporizing, inspecting, removal, and disposal of piping.

1..4..1..5. *Qualification* *GA*

Prior to start of work, submit documentation of recent experience and resumes of personnel working on the project.

1..4..1..6. *Spill and Discharge Control Plan* *GA*

Describe procedures and plan related to potential spills and discharge of contaminated soils and wash water.

1..4..2. *SD-18, Records*

a. *Contaminated soil disposal paperwork*; such as laboratory testing reports and treatment facility receipt. *GA*

b. *Contaminated wash water disposal paperwork*; such as laboratory testing results and treatment facility receipt. *GA*

1..5. AREAS OF CONTAMINATION

Assume for bidding purposes that all of the soil encountered during the excavation is contaminated with petroleum and shall be handled as specified herein. Wash water shall be collected and stored, and then removed and disposed of by the Contractor.

1..6. *QUALIFICATION*

Prior to start of work, submit data for approval showing that the piping removal Contractor, subcontractors, and personnel employed on the project have been engaged in removal, transportation, and disposal of piping and associated equipment, are familiar with and shall abide with the following:

a. \-API RP 1604-\.

b. Applicable safety rules and regulations.

c. Use of equipment and procedures for testing and vapor-freeing piping.

d. Handling and disposal of types of wastes encountered in pipe removal including disposal of piping.

e. Excavation, testing, and disposal of petroleum contaminated soils, and liquids.

In addition, furnish data proving experience on at least three prior projects which included types of activities similar to those in this project. Provide project titles, dates of projects, owners of projects, point of contact for each project, and phone numbers of each point of contact.

2. DISPOSITION BY CLASSIFICATION.

2..1. REINSTALLED. Items of material or equipment shown on the drawings or specified to be reinstalled in the work shall be jointly inspected by the Contractor and the Contracting Officer prior to dismantling or removal. An agreement shall be signed briefly setting forth the apparent condition of the material or equipment. Simple operating tests of operative equipment will be included with this joint inspection if feasible. Such items shall be reinstalled as specified in the applicable sections of the specifications covering new items of similar categories.

2..2. SALVAGED. Materials and equipment noted on the drawings or listed to be salvaged shall be carefully handled and protected and shall be delivered to the designated storage areas on the Government premises.

2..3. SCRAPPED. All removed materials and equipment not noted on the drawings or specified to be reinstalled, nor listed to be salvaged, shall be considered as scrap and shall be disposed of by the Contractor off the Government premises and credit for the value thereof, if any, shall have been reflected in the Contractor's bid prices.

3. REMOVALS. Removals of the various construction items shall be as follows:

3..1. CONCRETE. All removed concrete shall be scrapped. Edges of the existing floor slabs indicated to be removed, and which adjoin portions of retained floor slabs, shall first be outlined by scoring the surface to a depth of 2 inches with a concrete saw.

3..2. MISCELLANEOUS METAL. All removed miscellaneous metal including sheet metal items shall be scrapped except fabricated items noted to be reinstalled, which items shall be removed as complete units.

3..3. MECHANICAL. All removed mechanical materials shall be scrapped except items noted to be salvaged or reinstalled. Equipment noted to be salvaged shall have accessory items required for normal operation of the equipment, such as service valves and fittings, salvaged and attached to the unit.

3..4. ELECTRICAL. Electrical fixtures shown to be salvaged shall be cleaned and packaged for protection from breakage. All electrical equipment indicated to be salvaged shall be stored as directed.

4. PROTECTION OF PERSONS AND PROPERTY. During removal operations all persons and property shall be protected as required under CONTRACT CLAUSES "Permits and Responsibilities," "Operations and Storage Areas" and "Cleaning Up." Explosives shall not be used. The work shall proceed in such manner as to minimize the generation and spread of dust and flying particles.

5. DISCONNECTION OF SERVICES. Prior to starting removal operations in a given area, all utility lines which will be affected in that area shall be disconnected unless otherwise indicated or directed. Advance approved arrangements shall be made to prevent interference with utility services to rooms and structures not otherwise affected by work under this contract.

5..1. FIRE ALARM SYSTEMS. Cutting of fire alarm and other circuits shall be accomplished in such manner as to insure continued operation of the systems in the remaining building area.

5..2. PIPE ENDS AND PATCHING. Piping to equipment shall be disconnected at unions, flanges, and valves, or fittings. Except where otherwise noted or directed, protruding portions of abandoned conduit and piping shall be cut off below floor level and back of faces of retained wall and ceiling surfaces, as applicable. Open pipe ends shall be sealed or plugged. Such surfaces shall be patched, replaced or otherwise repaired to a condition comparable to adjacent undisturbed surfaces.

5..3. SAFETY. Precautions shall be taken while dismantling piping containing gas, gasoline, oil, or other explosives or injurious fluids. Such piping shall be stored outdoors until fumes are removed. During installation of new facilities and before removal of existing facilities, the operating and nonoperating utilities or facilities shall be identified for the safety of O&M personnel, the public, firemen, police, and others.

6. HANDLING OF CONTAMINATED MATERIALS

6..1. REMOVAL AND DISPOSAL OF PIPING

Furnish labor, materials, necessary permits, laboratory tests, and reports and equipment to remove and dispose of products remaining in the piping ; clean and vapor free the piping; excavate foundations, and backfill to the level of the adjacent ground; sample soil to determine if contaminated; dispose of piping and petroleum contaminated soil.

6..2. *SITE SAFETY AND HEALTH PLAN*\ (SSHP)

Furnish safety, health, and accident prevention provisions and develop a Site Safety and Health Plan (SSHP). The SSHP shall incorporate the requirements of \-29 CFR 1910-\ and \-COE EM-385-1-1-\ and be prepared, signed and sealed by a Certified Industrial Hygienist. Site work shall not start until the SSHP is approved by the Contracting Officer.

6..3. SITE SAFETY AND HEALTH OFFICER

Identify an individual to serve as the Site Safety and Health Officer (SSHO). The SSHO shall report problems and concerns regarding health and safety to the Contracting Officer. The SSHO shall have a working knowledge of local and Federal occupational safety and health regulations, and shall provide training

to Contractor employees in air monitoring practices and techniques. The SSHO shall also provide day to day industrial hygiene support, including air monitoring, training, and daily site safety inspections. The SSHO shall be trained in the use of the monitoring and sampling equipment, interpretation of data required to implement the SSHP, and to administer the elements of the SSHP. The SSHO shall remain on site during project operations and may be assigned other duties, such as project foreman or quality control manager.

6..4. *SPILL AND DISCHARGE CONTROL PLAN*

Develop, implement, and maintain a comprehensive spill and discharge control plan. The plan shall provide contingency measures for potential spills and discharges from handling and transportation of contaminated soils and water.

6..5. EXCLUSION ZONE (EZ) AND CONTAMINATION REDUCTION ZONE (CRZ)

Do not permit personnel not directly involved with the project to enter work zones, called the EZ and CRZ. The EZ shall be an area around the open piping a minimum of 10 feet from the limits of the piping removal . At the perimeter of the EZ, establish a CRZ. Limits of the CRZ shall be established by the Contractor. Within the CRZ, equipment and personnel shall be cleaned as stated in the paragraph entitled "Personnel and Equipment Decontamination." The Contractor's site office, parking area, and other support facilities shall be located outside the EZ and CRZ. Boundaries of the EZ and CRZ shall be clearly marked and posted. Include a site map, outlining the extent of work zones and location of support facilities, in the SSHP.

6..6. TRAINING

Provide health and safety training in accordance with \-29 CFR 1910-\ prior to starting work. Furnish copies of current training certification statements for personnel prior to initial entry into the work site.

6..6..1. On-Site Training

Prior to starting on-site work, a health and safety training class shall be held by the SSHO to discuss the implementation of the SSHP. Notify the Contracting Officer 24 hours prior to beginning the training class.

6..6..2. Training Outline

Provide the following:

a. Health and safety organization, including discussion of distribution of functions and responsibilities

b. Organization and components of the SSHP

c. Physical and chemical site hazard identification

d. Basic toxicology and toxicity information

e. Discussion of the EZ and CRZ

f. Protective clothing

g. Respiratory protection

h. Air quality monitoring

i. Personnel exposure guidelines

j. Decontamination procedures

k. Basic first aid review

l. Emergency procedures and contingency plan

m. Site entry and exit procedures

n. Sampling procedures

6..7. PERSONNEL PROTECTION

Furnish appropriate personal safety equipment and protective clothing to personnel and ensure that safety equipment and protective clothing is kept clean and well maintained. Furnish three clean sets of personal protective equipment and clothing for use by the Contracting Officer or official visitors as required for entry into the EZ.

6..8. RESPIRATORY PROTECTION PROGRAM

Develop a respiratory protection program, addressing respirator usage and training, in accordance with \-29 CFR 1910-\ and \-COE EM-385-1-1-\.

6..9. DECONTAMINATION

Decontaminate or properly dispose of personal protective equipment and clothing worn in contaminated areas at the end of the work day. The SSHO shall be responsible for ensuring that personal protective clothing and equipment are decontaminated before being reissued.

6..10. FIRST AID AND EMERGENCY RESPONSE EQUIPMENT AND PROCEDURES

Provide appropriate emergency first aid equipment for treatment of exposure to site physical and chemical hazards. Provide and post a list of emergency phone numbers and points of contact for fire, hospital, police, ambulance, and other necessary contacts. Provide and post a route map detailing the directions to the nearest medical facility.

6..11. IGNITION SOURCES

Do not permit ignition sources in the EZ and CRZ.

6..12. PERSONNEL AND EQUIPMENT DECONTAMINATION

Decontaminate personnel and equipment before exiting the work zones.

6..13. WASTE DISPOSAL

The SSHP shall detail the practices and procedures to be utilized to dispose of wastes. Upon completion of the project, certify that equipment and materials were properly decontaminated prior to being removed from the site.

6..14. EMERGENCY RESPONSE REQUIREMENTS

Furnish emergency response and contingency plan in accordance with \-29 CFR 1910-\. In an emergency, take action to remove or minimize the cause of the emergency, alert the Contracting Officer, and institute necessary measures to prevent repetition of the emergency. Equip site-support vehicles with route maps providing directions to the medical treatment facility.

6..15. UNFORESEEN HAZARDS

Notify the Contracting Officer of any unforeseen hazard or condition which becomes evident during work.

6..16. TEMPORARY CONTAINMENT OF EXCAVATED SOIL

Provide temporary containment area near the excavated area. Cover containment area with 30 mil polyethylene sheeting. Place excavated soil on the impervious barrier and cover with 6 mil polyethylene sheeting. Provide straw bale berm around the outer limits of the containment area and cover with polyethylene sheets. Secure edges of sheets to keep the polyethylene sheeting in place.

6..17. EXCAVATION

Notify the Contracting Officer at least 48 hours prior to start of tank removal work. Stage operations to minimize the time that tank excavation is open and the time that contaminated soil is exposed to the weather. Provide protection measures around the excavation area to prevent water runoff and to contain the soil within the excavation area.

6..17..1. Excavation Procedures

Excavate as required for foundations . Place soil removed from the excavation in a temporary containment area. Collect and temporarily store water runoff from stockpiled soils. Contaminated soil shall be tested and disposed of in accordance with North Carolina Department of Environmental Health and Natural Resources.

6..17..2. Excavation Methods

Select methods and equipment to remove soil to minimize disturbance to areas beyond the limits of the excavation area. Material that becomes contaminated as a result of the Contractor's operations shall be removed and disposed of at no additional cost to the Government.

6..18. SPILLS OF CONTAMINATED SOILS

Use appropriate vehicles and operating practices to prevent spillage or leakage of contaminated materials from occurring during operations. Inspect vehicles leaving the area of contamination to ensure that no contaminated materials adhere to the wheels or undercarriage.

6..19. BACKFILL

Provide backfill, compaction, grading, and seeding in accordance with Section \=02210=\, "GRADING".

7. CLEANING UP on a continuing basis shall be provided as required under CONTRACT CLAUSES clause "Cleaning Up."

SECTION 02210

GRADING

SECTION 02210

GRADING

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM D 1556-\	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
\-ASTM D 1557-\	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
\-ASTM D 2167-\	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
\-ASTM D 2487-\	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1..2. DEFINITIONS

1..2..1. Satisfactory Materials

Materials classified in \-ASTM D 2487-\ as SP, SC, SM, CL, CH, ML, GM, GW, GP, and SW, and free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 6 inches in any dimension are satisfactory.

1..2..2. Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in \-ASTM D 2487-\ as MH, Pt, OH, and OL are unsatisfactory. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

1..2..3. Cohesionless and Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Cohesionless materials include materials classified in \-ASTM D 2487-\ as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.

1..2..4. Degree of Compaction

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in \-ASTM D 1557-\ abbreviated below as a percent of laboratory maximum density.

1..2..5. Topsoil

Material obtained from offsite areas and/or excavations.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-09 Reports\

Field Testing Control\; *FIO*\.

Copies of all laboratory and field test reports to the Contracting Officer within 24 hours of the completion of the test.

PART 2. PRODUCTS

2..1. NOT USED

2..2. BORROW MATERIAL

2..2..1. Selection

Borrow materials shall be obtained from sources outside the limits of Government-controlled land. Borrow materials shall be subject to approval. The source of borrow material shall be the Contractor's responsibility. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, shall pay all royalties and other charges involved, and shall bear all the expense of developing the sources, including rights-of-way for hauling.

2..2..2. Borrow Pits

Except as otherwise permitted, borrow pits shall be excavated to afford adequate drainage. Overburden and other spoil material shall be disposed of or used for special purposes. Borrow pits shall be neatly trimmed after the excavation is completed.

PART 3. EXECUTION

3..1. CONSERVATION OF TOPSOIL

Where indicated, topsoil shall be removed to a depth of 4 inches without contamination with subsoil and stockpiled convenient to areas for later application or at locations specified. Topsoil shall be removed to full depth and shall be stored separate from other excavated materials and piled free of roots, stones, and other undesirable materials. Any surplus of topsoil from excavations and grading shall be removed from the site.

3..2. EXCAVATION

Excavation of every description, regardless of material encountered, within the grading limits of the project shall be performed to the lines and grades

indicated. Satisfactory excavation material shall be transported to and placed in fill areas within the limits of the work. All unsatisfactory material and surplus material shall be removed from site . In the event that it is necessary to remove unsatisfactory material to a depth greater than specified, the Contracting Officer shall be notified. Excavations carried below the depths indicated, without specific directions, shall, except as otherwise specified, be refilled to the proper grade with satisfactory material as directed. All additional work of this nature shall be at the Contractor's expense. Excavation and filling shall be performed in a manner and sequence that will provide drainage at all times. Excavations shall be kept free from water.

3..3. DITCHES, GUTTERS, AND CHANNEL CHANGES

Ditches, gutters, and channel changes shall be cut accurately to the cross sections and grades indicated. Care shall be taken not to excavate ditches and gutters below the grades indicated. Excessive ditch and gutter excavation shall be backfilled to grade with satisfactory, thoroughly compacted material or with suitable stone or as directed. All ditches and gutters excavated under this section shall be maintained until final acceptance of the work. No excavated material shall be deposited closer to the edges of the ditches than indicated and in no case less than 3 feet.

3..4. BACKFILL ADJACENT TO STRUCTURES

Backfill adjacent to structures shall be placed and compacted uniformly in such manner as to prevent wedging action or eccentric loading upon or against the structures. Slopes bounding or within areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. Backfill for storm drains and subdrains, including the bedding and backfill for structures other than culverts and drains, shall conform to the additional requirements in other applicable sections.

3..5. PREPARATION OF GROUND SURFACE FOR FILL

All vegetation, such as roots, brush, heavy sods, heavy growth of grass, and all decayed vegetable matter, rubbish, and other unsatisfactory material within the area upon which fill is to be placed, shall be removed before the fill is started. In no case will unsatisfactory material remain in or under the fill area. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped, or broken up, as directed, in such manner that the fill material will bond with the existing surface. Prepared surfaces on which compacted fill is to be placed shall be wetted or dried as may be required to obtain the specified moisture content and density.

3..6. FILLS AND EMBANKMENTS

Fills and embankments shall be constructed at the locations and to lines and grades indicated. Stones having a dimension greater than 4 inches shall not be permitted in the upper 6 inches of fill or embankment. The material shall be placed in successive horizontal layers of 8 to 12 inches in loose depth for the full width of the cross section and shall be compacted as specified. Each layer shall be compacted before the overlaying lift is placed. Moisture content of the fill or backfill material shall be adjusted as required, to

within plus or minus 4 percent of optimum moisture content as determined from laboratory tests specified in paragraph DEFINITIONS.

3..7. COMPACTION

Except for paved areas, each layer of the fill or embankment shall be compacted to at least 90 percent of laboratory maximum density. Areas to be paved and other areas indicated as requiring compaction suitable for paved areas shall be compacted to a density of 95% laboratory maximum density for minimum compacted subgrade thickness as shown on the drawings.

3..8. FINISHED EXCAVATION, FILLS, AND EMBANKMENTS

All areas covered by the project shall be uniformly smooth-graded, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations, except as otherwise specified. Ditches and gutters shall be finished to permit adequate drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials. For subgrade areas to be paved, the following shall be accomplished as required: (a) soft or otherwise unsatisfactory material shall be replaced with satisfactory excavated material or other approved materials; (b) rock encountered in the cut sections shall be excavated to a depth of 6 inches below finished grade for the subgrade; (c) low areas resulting from removal of unsatisfactory material or from excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and shall be compacted as specified. The surface of embankments or excavated areas for road construction or other areas on which a base course or pavement is to be placed shall vary not more than 0.05 foot from the established grade and approved cross section. Surfaces other than those that are to be paved shall be finished not more than 0.15 foot above or below the established grade or approved cross section.

3..9. PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2 inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 4 inches and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from off-site areas.

3..10. NOT USED

3..11. \+*FIELD TESTING CONTROL*\+

Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Field density and moisture content tests shall be performed on every 5000 square feet of each lift placed. Field in-place density shall be determined in accordance with \-ASTM D 1556-\ or \-ASTM D 2167-\.

3..12. PROTECTION

Newly graded areas shall be protected from traffic and from erosion, and any settlement or washing away that may occur from any cause, prior to acceptance,

shall be repaired and grades reestablished to the required elevations and slopes. All work shall be conducted in accordance with the environmental protection requirements of the contract.

SECTION 02222

EARTHWORK FOR UTILITIES SYSTEMS

SECTION 02222

EARTHWORK FOR UTILITIES SYSTEMS

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM D 422-\	(1963; R 1990) Particle-Size Analysis of Soils
\-ASTM D 1556-\	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
\-ASTM D 1557-\	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
\-ASTM D 2167-\	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
\-ASTM D 2487-\	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
\-ASTM D 2922-\	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1..2. NOT USED

1..3. DEFINITIONS

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in \-ASTM D 1557-\.

1..4. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-09 Reports\

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2. PRODUCTS

2..1. SATISFACTORY MATERIALS

Satisfactory materials shall consist of any material classified by \-ASTM D 2487-\ as GW, GP, and SW.

2..2. UNSATISFACTORY MATERIALS

Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and materials classified in \-ASTM D 2487-\, as PT, OH, and OL.

2..3. COHESIONLESS AND COHESIVE MATERIALS

Cohesionless materials shall include materials classified in \-ASTM D 2487-\ as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

2..4. UNYIELDING MATERIAL

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2..5. UNSTABLE MATERIAL

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2..6. SELECT GRANULAR MATERIAL

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the l inch sieve. The maximum allowable aggregate size shall be 1 inch per foot of pipe diameter not to exceed 3 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2..7. INITIAL BACKFILL MATERIAL

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 2 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller.

2..8. PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.

Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

PART 3. EXECUTION

3..1. EXCAVATION

Excavation shall be performed to the lines and grades indicated. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench at least 1/2 the depth of the excavation, but no closer than 2 feet. The trench shall be excavated as recommended by the manufacturer of the pipe to be installed.

3..1..1. Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3..1..2. Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials.

3..1..3. Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material compacted in lifts not exceeding 6 inches in loose thickness. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3..1..4. Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care

shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3..1..5. Jacking, Boring, and Tunneling

Unless otherwise indicated or approved, excavation shall be by open cut.

3..1..6. Stockpiles

Stockpiles of materials shall be placed and graded as specified or indicated. Stockpiles shall be kept in a neat and well drained condition. The ground surface at stockpile locations shall be cleared, grubbed, and sealed. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government.

3..2. BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3..2..1. Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

3..2..1..1. Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3..2..1..2. Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Roadways, Railroads, and Airfields: Backfill shall be placed up to the elevation at which the requirements in Section \=02210=\ GRADING control. Water flooding or jetting methods of compaction will not be permitted.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent

maximum density for cohesionless soils. Water flooding or jetting methods of compaction will be permitted for granular noncohesive backfill material. Water jetting shall not be allowed to penetrate the initial backfill. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

3..2..2. Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3..3. SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are:

3..3..1. NOT USED

3..3..2. NOT USED

3..3..3. NOT USED

3..3..4. Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3..3..5. Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown.

3..4. TESTING

3..4..1. Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

3..4..2. Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils \-ASTM D 422-\ and moisture-density relations of soils \-ASTM D 1557-\. A minimum of one particle size analysis and one

moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3..4..3. \+Field Density Tests+

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 100 feet of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance with \-ASTM D 1556-\, \-ASTM D 2167-\, or \-ASTM D 2922-\. Copies of field and laboratory density tests shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

3..4..4. Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to at least 2 feet above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

SECTION 02511A

CONCRETE SIDEWALKS

SECTION 02511A

CONCRETE SIDEWALKS

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM C 94-\	(1992) Ready-Mixed Concrete
\-ASTM C 143-\	(1990a) Slump of Hydraulic Cement Concrete
\-ASTM C 309-\	(1991) Liquid Membrane-Forming Compounds for Curing Concrete
\-ASTM D 1751-\	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
\-ASTM D 1752-\	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
\-ASTM D 3405-\	(1994) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

CORPS OF ENGINEERS (COE)

\-COE CRD-C 527-\	(1988) Standard Specification for Joint Sealants, Cold-Applied, Non-Jet-Fuel-Resistant, for Rigid and Flexible Pavements

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-18 Records\

Concrete\; *GA*\.

Copies of certified delivery tickets for all concrete used in the construction.

1..3. WEATHER LIMITATIONS

Concrete placement shall be discontinued when the air temperature is below 40 degrees F and is falling.

1..4. PLANT, EQUIPMENT, MACHINES, AND TOOLS

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

PART 2. PRODUCTS

2..1. CONCRETE

\-ASTM C 94-\, cement type I. Only one brand of any one type of cement shall be used for exposed concrete surfaces of any individual structure. Concrete mixes shall be proportioned to obtain compressive strength in 28 days of 3000 psi. The compressive strength shall be reached in 7 days when high-early-strength cement is used. The maximum size of aggregate shall be 1-1/2 inches. Total air content of exterior concrete shall be maintained at 5 to 7 percent by volume of concrete. Slump shall be not more than 3 inches as determined by \-ASTM C 143-\.

2..2. CURING MATERIALS

Impervious sheet or membrane-forming curing compound. Impervious sheet shall be white opaque polyethylene 4 mil thick, waterproof kraft paper, or polyethylene-coated burlap. Membrane-forming curing compound shall be white pigmented and shall conform to \-ASTM C 309-\, Type 2.

2..3. CONCRETE PROTECTION MATERIALS

Linseed oil mixture shall be equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used except that emulsified mixtures are not acceptable.

2..4. JOINT FILLER STRIPS

Expansion joint filler shall be premolded, nonextruding type for use in concrete conforming to \-ASTM D 1751-\ or \-ASTM D 1752-\, 3/8 inch thick, unless otherwise indicated.

2..5. JOINT SEALANTS

2..5..1. Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to \-COE CRD-C 527-\.

2..5..2. Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to \-ASTM D 3405-\.

2..6. FORM WORK

Form work shall be designed and constructed to insure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of a height equal to the full depth of the finished sidewalk.

PART 3. EXECUTION

3..1. SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted to conform with applicable requirements of Section \=02210=\ GRADING. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected so as to produce a subgrade free from frost when the concrete is deposited.

3..2. FORM SETTING

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope as indicated of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3..3. SIDEWALK CONCRETE PLACEMENT AND FINISHING

3..3..1. Formed Sidewalks

Concrete shall be placed in the forms in one layer of such thickness that when consolidated and finished the sidewalks will be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a wood float, bull float, or darby, edged and broom finished.

3..3..2. Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.

3..3..3. Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3..3..4. \+Surface and Thickness Tolerances+\

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10 foot straightedge. Permissible deficiency in section thickness will be up to 0.25 inch.

3..4. SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement.

3..4..1. Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness.

3..4..2. Expansion Joints

Expansion joints shall be formed with 1/2 -inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and shall be held in place to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer. Concrete at the joint shall be surface dry and the atmospheric and pavement temperatures shall be above 50 degrees F at the time of application of joint-sealing materials. Joints shall be filled with sealer flush with the concrete surface in such manner as to minimize spilling on the walk surface. Spilled sealing material shall be removed immediately and the surface of the walk cleaned.

3..5. CURING AND PROTECTION

3..5..1. General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period. Membrane forming curing compound shall be applied in accordance with the manufacturer's recommendations.

3..5..2. Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3..5..3. Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction.

3..5..4. Protective Coating

Protective coating of linseed oil mixture shall be applied to exposed-to-view concrete surfaces.

3..5..4..1. Application

Curing and backfilling operation shall be completed prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. Coverage shall be not more than 50 square yards per gallon for first application and not more than 70 square yards per gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3..5..4..2. Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at temperatures lower than 50 degrees F.

3..6. SURFACE DEFICIENCIES AND CORRECTIONS

Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which exceed plan grade, surface smoothness, or thickness tolerances shall be corrected as directed by the Contracting Officer.

SECTION 02935
TURF

SECTION 02935
TURF

PART 1 GENERAL

1.1 SUMMARY

Seed varieties and quantities specified shall be uniformly distributed over all ground areas disturbed by grading and/or trenching and not otherwise surfaced and in such manner that will produce an even stand of grass over the entire area seeded and as specified.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AGRICULTURAL MARKETING SERVICE (AMS)

AMS-01(Amended Thru: Aug 1988) Federal Seed Act Regulations (Part 201-202)

COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-1909 (Basic) Fertilizer

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS DESCRIPTIONS

SD-08 Statements\

Maintenance Report\; *FIO*\.

Written record of all maintenance work performed during the turf establishment period shall be submitted to the Contracting Officer.

SD-13 Certificates\

Certificates of compliance certifying that materials meet the requirements specified, in accordance with paragraph MATERIALS, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

Seed\; *GA2*\.

For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, date tested, and state certification.

1.4 INSPECTION, STORAGE, AND HANDLING

1.4.1 Inspection

Seed, shall be inspected upon arrival at the job site by the Contracting Officer for conformity to type and quality in accordance with paragraph MATERIALS.

1.4.2 Storage

Materials shall be stored in areas designated by the Contracting Officer. Seed, Fertilizer, Lime shall be stored in cool, dry locations away from contaminants.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 *Seed*

2.1.1.1 Seed Classification

State Certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws.

2.1.1.2 Seed Mixtures

Seed mixtures shall be proportioned by weight as follows:

Name	Mixture Percent by Weight	Pounds of Seed Per 1,000 S.F.
Common Bermudagrass	10	0.8
Turf Type Tall Fescue Rebel II or Rebel III	90	7.2
	Total	8.0

2.1.1.3 Quality

Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected.

2.1.1.4 Seed Mixing

The mixing of the seed shall be done by the Seed Supplier prior to delivery to the site. Bulk quantities of seed shall be labeled as required in the paragraph Seed Classification.

2.1.2 Soil Amendments

Soil amendments shall consist of fertilizer and lime meeting the following requirements.

2.1.2.1 Fertilizer

Fertilizer shall be commercial grade, free flowing, low in salts, uniform in composition and conforming to CID A-AA-1909. Granular fertilizer shall

consist of nitrogen-phosphorus-potassium, ratio: 10 parts nitrogen, 20 parts phosphorus, and 10 parts potassium.

2.1.2.2 Lime

Lime shall be agricultural limestone and shall have a minimum calcium magnesium oxides equivalent of 50 percent and shall be ground to such a fineness that at least 90 percent will pass a 10-mesh sieve and at least 50 percent will pass a 60-mesh sieve.

2.1.3 Topsoil

If additional topsoil is required beyond that available from grading operations, it shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils in the vicinity, and approved by the Contracting Officer. It shall be obtained from well-drained areas and shall be free of any admixture of subsoil, foreign matter, objects larger than 1 inch in any dimension, toxic substances, and any material or substance that may be harmful to plant growth. Topsoil shall be in accordance with Section 02210 GRADING.

2.1.4 Mulch

The Contractor shall use hay or straw fixed in place on all surfaces. All other mulch materials and/or methods of application shall be approved by the Contracting Officer. Mulch shall be free from weeds, mold, and other objectionable materials. Contractor shall also have the option of using Hydromulch with tackifier applied simultaneously with grass, seed, and fertilizer by the use of hydroseeding machinery on slopes less than 3 horizontal to 1 vertical.

2.1.4.1 Straw

Straw Mulch shall be long stem threshed straw of oats, wheat or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain at least 50 percent by weight of the material to be 10 inches or longer. Straw shall be in an air-dry condition and suitable for placing with blower equipment.

2.1.4.2 Hay

Hay shall be native prairie hay furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment. Hay shall be free of noxious weeds, mold or other objectionable material.

2.1.4.3 Hydromulch for Hydroseeding

Hydromulch shall be made of virgin, long fiber wood cellulose made from whole wood chips or lumber remnants and not contain any growth or germination inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0. Hydromulch shall include a tackifier to provide added bonding between cellulose fibers and to help hold seed, fertilizer and soil in place and to promote seed germination. Tackifier shall weigh a minimum 3%, on an air dry weight basis, of the mulch mix.

2.1.4.4 Hydromulch Tackifier

Hydromulch tackifier shall be a natural vegetable gum, blended with gelling and hardening agents. When mixed with water this material becomes a tackifier/binder to act as an agent for erosion control and provides a stable bed for seed germination.

2.1.4.5 Paperfiber Mulch Overspray

Paperfiber mulch overspray shall be produced from slick paper containing wood cellulose and kaolin clay, recycled newsprint or cardboard will not be allowed. The material is shredded for the purpose of mulching as an overspray binder on straw mulched areas. It shall not contain any growth or germination-inhibiting substances. The mulch shall be green in color for visual metering of the material application. Composition on an air dry weight basis shall be: 8 percent moisture content, pH range 4.5 to 6.5.

2.1.5 Water

Water shall not contain elements toxic to plant life and shall be obtained from an approved source prior to use.

PART 3 EXECUTION

3.1 SEEDING TIMES AND CONDITIONS

3.1.1 Seeding Time

Seed shall be sown for spring planting from March 15 to June 1, for fall planting from August 1 to Oct 15.

3.1.2 Environmental Conditions

Seeding, operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the operations, proposed times shall be submitted to and approved by the Contracting Officer.

3.2 SITE PREPARATION

3.2.1 Grading

The Contracting Officer shall verify that finished grades are as indicated on the drawings, and the placing of topsoil and smooth grading have been completed in accordance with Section 02210 GRADING. Any deviations therefrom shall be corrected prior to seeding. Soil used for repair of erosion and correction of grade deficiencies shall conform to that specified in the paragraph Topsoil.

3.2.2 Tillage

3.2.2.1 Minimum Depth

Soil on slopes gentler than 3-horizontal-to-1-vertical shall be tilled to a minimum depth of 6 inches. Slopes between 3-horizontal-to-1-vertical and

1-horizontal-to-1 vertical, the soil shall be tilled to a minimum depth of 2 inches by scarifying with heavy rakes, rotating chains drawn by tractor from the top of the slope, or rototillers when soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required.

3.2.3 Finished Grading

3.2.3.1 Preparation

Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage. Finished grades adjacent to walks, curbs, pavements, shall be 1 inch below the adjoining surfaced area. New soil surfaces shall be blended to meet existing soil surfaces.

3.2.3.2 Grass Area Debris

Grass areas shall have debris and stones larger than 1 inch in any dimension removed from the surface.

3.2.3.3 Protection

Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

3.2.4 Application of Soil Amendments

3.2.4.1 Lime

Lime shall be applied at the rate of 2 tons per acre. Lime shall be incorporated into the soil to a minimum depth of 6 inches or may be incorporated as part of the tillage operation.

3.2.4.2 Fertilizer

Fertilizer shall be applied at a rate of 1 pound of actual nitrogen per 1,000 square feet for seeding. Fertilizer shall be incorporated into the soil to a minimum depth of 6 inches or may be incorporated as part of the tillage or hydroseeding operation. Fertilizer may be applied simultaneously with seed and hydromulch when hydroseeding.

3.3 SEEDING

3.3.1 General

Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rain, traffic or other cause, shall be reworked to restore the ground condition previously specified. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.2 Applying Seed

3.3.2.1 Broadcast Seeding

Seed shall be uniformly broadcast at the rates specified using broadcast seeders. Half of seed shall be broadcast in one direction, and the remainder at right angles to the first direction. Seed shall be covered to an average depth of 1/4 inch but no more than 3/4 inch by steel mat drag, cultipacker, or other approved device.

3.3.2.2 Drill Seeding

Seed shall be uniformly drilled to an average depth of 1/2 inch at the rate specified using a Brillon type seeder. Row markers shall be used with the drill seeder. Drill seeding shall be done in two directions, 90 degrees in direction from the other, each direction at half the rate specified.

3.3.2.3 Rolling

Immediately after seeding, except for slopes 3-horizontal-to-1 vertical and greater, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with seed drills equipped with rollers shall not be rolled.

3.3.3 Hydroseeding

Seed and fertilizer shall be added to water and thoroughly mixed at the rates specified. Hydromulch and Tackifier shall be added after the seed, fertilizer and water have been thoroughly mixed. Mix shall include a minimum of 1,500 pounds of mulch and tackifier, per acre, on slopes 2.5H : 1V or flatter and 2,000 pounds of mulch and tackifier, per acre, on slopes steeper than 2.5H : 1V. Slurry shall be uniformly applied to all seeded surfaces. Adequate soil moisture shall be ensured by spraying water on the entire hydroseeded area and moisten the soil to a minimum depth of 2 inches prior to hydroseeding. The hydroseeded area shall not be rolled.

3.3.4 Mulching

Mulching shall be performed the same day as seeding. Unless specified otherwise mechanical anchoring of mulch shall be performed.

3.3.4.1 Straw or Hay Mulch

Straw or hay mulch shall be spread uniformly, in a continuous blanket, at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a steep slope and continued uniformly until the area is covered. The mulch shall not be bunched. All seeded areas shall be mulched on the same day as the seeding.

3.3.4.2 Mechanical Anchoring

Immediately following spreading, the mulch shall be anchored to the soil by a V-type-wheel land packer, a scalloped-disk land packer designed to force mulch into the soil surface a minimum of 2 inches, or other suitable equipment.

3.3.4.3 Hydromulch

Hydromulch for use with the hydraulic application of seed, fertilizer and tackifier shall be applied as part of the hydroseeding operation.

3.3.5 Watering Seeded Areas

Watering of seeded areas is not required.

3.4 RESTORATION AND CLEAN UP

3.4.1 Restoration

Existing turf areas, pavements and facilities that have been damaged from the turfing operation shall be restored to original condition at Contractor's expense.

3.4.2 Clean Up

Excess and waste material shall be removed from the planting operation and shall be disposed of off the site. Adjacent paved areas shall be cleaned.

3.5 PROTECTION OF TURFED AREAS

Immediately after mulching operations have been completed, the area shall be protected against traffic or other use by erecting barricades and providing signage as required or as directed by the Contracting Officer to provide protection against traffic and trespass.

3.6 TURF ESTABLISHMENT PERIOD

3.6.1 Commencement

The Turf Establishment Period for establishing a healthy stand of turf shall begin on the first day of work under this contract and shall end 60 days after the last day of mulching operations required by this contract or until all work on this entire Contract has been completed and accepted, whichever period is longer.

3.6.1.1 Satisfactory Stand of Turf

A satisfactory stand of turf for a seeded area is defined as having a minimum of 200 grass plants per square foot and having a mat like appearance. Bare spots shall be no larger than 6 square inches per foot. The total bare spots shall not exceed 2 percent of the total seeded area.

3.6.2 Maintenance During Turf Establishment Period

3.6.2.1 General

Maintenance of the turfed areas shall include eradicating weeds when evident, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining mulch, protecting turfed areas from traffic and mowing.

3.6.2.2 Mowing

Grass areas shall be mowed to a minimum height of 2-1/2 inches when the average height of the turf becomes 4 inches. Clippings shall be removed when the amount of cut turf is heavy enough to damage the turfed areas.

3.6.2.3 Repair

The Contractor shall re-establish as specified herein, eroded, damaged or barren areas. Mulch shall also be repaired or replaced as required.

3.6.2.4 *Maintenance Report*

A written record shall be furnished to the Contracting Officer of the maintenance work performed.

3.7 FINAL ACCEPTANCE

See specification SECTION, 01440, CONTRACTOR QUALITY CONTROL, for final inspection and acceptance.

SECTION 03300A

CONCRETE FOR BUILDING CONSTRUCTION

SECTION 03300A

CONCRETE FOR BUILDING CONSTRUCTION

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

\-ACI 318/318R-\	(1989; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 615-\	(1994) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
\-ASTM C 94-\	(1994) Ready-Mixed Concrete
\-ASTM C 309-\	(1993) Liquid Membrane-Forming Compounds for Curing Concrete

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-13 Certificates\

Cementitious Materials\; *GA*\.

Cement, pozzolan, and ground iron blast-furnace slag will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished. No cement, pozzolan, or slag shall be used until notice of acceptance has been given by the Contracting Officer. Cement, pozzolan, and slag may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

1..3. GENERAL REQUIREMENTS

1..3..1. Strength Requirements

Structural concrete for all work shall have a 28-day compressive strength of 3000 pounds per square inch. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

1..3..2. Air Entrainment

All concrete shall contain from 4 to 7 percent total air.

1..3..3. Special Properties

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved.

1..3..4. Slump

Slump shall be within the following limits:

Structural Element	Slump in inches Minimum	Maximum
Foundation walls, substructure walls, footings, pavement, and slabs	1	3
Any structural concrete approved for placement by pumping	None	6

Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

PART 2. PRODUCTS

2..1. CONCRETE INGREDIENTS

Concrete shall conform to \-ASTM C 94-\; type V.

2..2. CURING MATERIALS

Curing materials shall be burlap, impervious sheets, or membrane-forming compounds.

2..3. EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel.

2..4. FORM MATERIALS

Forms for concrete surfaces shall be metal, plywood, or hardboard capable of producing the required surface without adverse effect on the concrete. Form coating shall be nonstaining form oil or form release agent that will not adversely affect the concrete surfaces or impair subsequent applications to the concrete. Form ties shall be metal, factory-fabricated, removable or snap-off type that will not leave holes less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter.

2..5. NOT USED

2..6. NOT USED

2..7. REINFORCEMENT

Bar reinforcement shall be deformed, Grade 40 or Grade 60 billet steel conforming to \-ASTM A 615-\. Mesh reinforcement shall be welded steel wire fabric with wires at right angles to each other.

2..8. NOT USED

2..9. WATER

Water shall be potable.

PART 3. EXECUTION

3..1. PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance. Surfaces shall be moist but without free water when the concrete is placed.

3..2. FORMWORK

Formwork shall be mortar-tight, properly aligned, and adequately supported to produce concrete conforming accurately to the indicated shapes, lines, dimensions, and with surfaces free of offsets, waviness, or bulges. Where surfaces are to be exposed or painted, panels shall be of uniform sizes, using smaller panels only where required by openings, joints or for closure. Unless otherwise shown, exposed external corners shall be chamfered, beveled or rounded by moldings placed in the forms. Form surfaces shall be thoroughly cleaned and coated before each use. Forms shall be removed at a time and in a manner that will not injure the concrete.

3..3. INSTALLATION OF REINFORCEMENT

Reinforcement shall be fabricated to the required shapes. Reinforcement shall be interrupted 2 inches on each side of expansion joints. Reinforcement shall be accurately positioned and secured in place.

3..4. NOT USED

3..5. NOT USED

3..6. INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3..7. BATCHING, MIXING AND TRANSPORTING CONCRETE

The work shall conform to \-ACI 318/318R-\ part Construction Requirements, except as otherwise specified.

3..8. CONCRETE PLACEMENT

Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 8 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3..9. CONSOLIDATION

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

3..10. WEATHER LIMITATIONS

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The temperature of the concrete placed during warm weather shall not exceed85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95degrees F.~\

3..11. CONSTRUCTION JOINTS

Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer.

3..12. FINISHING CONCRETE

3..12..1. Formed Surfaces

Fins and loose material shall be removed. Unsound concrete, voids over 1/2 inch in diameter, and tie-rod bolt holes shall be cut back to solid concrete, reamed, brush-coated with cement grout, and filled solid with a stiff portland cement and sand mortar mix. Patchwork shall finish flush with adjoining concrete surfaces in texture and color. Patchwork shall be cured for 72 hours.

3..12..2. Unformed Surfaces

3..12..2..1. Rough-Slab Finish

Slabs to receive fill or mortar setting beds shall be screeded with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

3..12..2..2. Float Finish

Slabs to receive a steel trowel finish float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Lightweight concrete or concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections.

3..12..2..3. Trowel Finish

All slabs shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand.

3..13. CURING AND PROTECTION

3..13..1. General

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period.

3..13..2. Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2 inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3..13..3. Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except a styrene acrylate or chlorinated rubber compound meeting \-ASTM C 309-\, Class B requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3..14. SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 1 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

SECTION 05120

STRUCTURAL STEEL

SECTION 05120

STRUCTURAL STEEL

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

\-AISC S303-\	(1992) Code of Standard Practice for Steel Buildings and Bridges
\-AISC S335-\	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 36-\	(1994) Carbon Structural Steel
\-ASTM A 307-\	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
\-ASTM A 500-\	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
\-ASTM F 844-\	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B18.21.1-\	(1994) Lock Washers (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

\-AWS A2.4-\	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
\-AWS D1.1-\	(1994) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC Paint 25-\	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1..2. GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication,

and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of \-AISC S329-\. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. \-AISC-S335-\ shall govern the work. Welding shall be in accordance with \-AWS D1.1-\. .

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Structural Steel System\; *GA1*\.

Structural Connections\; *GA1*\.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with \-AWS A2.4-\.

SD-13 Certificates\

Mill Test Reports\; *FIO*\.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items.

Welder Qualifications\; *FIO*\.

Certified copies of welder qualifications test records showing qualification in accordance with \-AWS D1.1-\.

SD-14 Samples\

Carbon Steel Bolts and Nuts\; *FIO*\.

Washers\; *FIO*\.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1..4. STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

PART 2. PRODUCTS

2..1. STRUCTURAL STEEL

2..1..1. Carbon Grade Steel

Carbon grade steel shall conform to \-ASTM A 36-\ .

2..2. STRUCTURAL TUBING

Structural tubing shall conform to \-ASTM A 500-\, Grade B .

2..3. NOT USED

2..4. NOT USED

2..5. NOT USED

2..6. CARBON STEEL BOLTS

Carbon steel bolts shall conform to \-ASTM A 307-\, Grade A with carbon steel nuts conforming to \-ASTM A 563-\, Grade A.

2..7. NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Hex Style .

2..8. *WASHERS*

Plain washers shall conform to \-ASTM F 844-\. Other types, when required, shall conform to \-ASME B18.21.1-\ .

2..9. PAINT

Paint shall conform to \-SSPC Paint 25-\.

PART 3. EXECUTION

3..1. FABRICATION

Fabrication shall be in accordance with the applicable provisions of \-AISC-04-\. Fabrication and assembly shall be done in the shop to the greatest extent possible. Structural steelwork, except surfaces of steel to be encased in concrete and surfaces to be field welded shall be prepared for painting in accordance with the \-AISC-04-\ and primed with the specified paint.

3..2. ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of \-AISC-S335-\.

3..2..1. Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work.

3..2..2. Base Plates and Bearing Plates

Column base plates for columns and bearing plates for similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar. Bedding mortar be as specified in Section \=03300=\ CONCRETE FOR BUIDLING CONSTRUCTION.

3..2..3. Field Welded Connections

Field welded structural connections shall be completed before load is applied.

3..2..4. Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

SECTION 05300

STEEL DECKING

SECTION 05300

STEEL DECKING

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

\-AISC-04-\ (1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 611-\ (1994) Steel, Sheet, Carbon, Cold-Rolled, Structural Quality

\-ASTM A 653-\ (1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip Process

\-ASTM A 780-\ (1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

AMERICAN WELDING SOCIETY (AWS)

\-AWS D1.1-\ (1994) Structural Welding Code - Steel

\-AWS D1.3-\ (1989) Structural Welding Code - Sheet Steel

STEEL DECK INSTITUTE (SDI)

\-SDI Pub No 28-\ (1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC Paint 20-\ (1991) Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Deck Units\; *GA1*\.

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

SD-13 Certificates\

Deck Units\; *GA*\.

Attachments\; *GA*\.

Manufacturer's certificates attesting that the decking material meets the specified requirements. Manufacturer's certificate attesting that the operators are authorized to use the low-velocity piston tool.

1..3. DELIVERY, STORAGE, AND HANDLING

Deck units shall be delivered to the site in a dry and undamaged condition, stored off the ground with one end elevated, and stored under a weathertight covering permitting good air circulation. Finish of deck units shall be maintained at all times by using touch-up paint whenever necessary to prevent the formation of rust.

PART 2. PRODUCTS

2..1. *DECK UNITS*

Deck units shall conform to \-SDI Pub No 28-\. Panels of maximum possible lengths shall be used to minimize end laps.

2..1..1. Roof Deck

Steel deck used in conjunction with insulation and built-up roofing shall conform to \-ASTM A 653-\, \-ASTM A 611-\ or \-ASTM A 792-\. Roof deck units shall be fabricated of 0.0295 inch design thickness or thicker steel and shall be shop painted or galvanized .

2..2. TOUCH-UP PAINT

Touch-up paint for shop-painted units shall be of the same type used for the shop painting, and touch-up paint for zinc-coated units shall be an approved galvanizing repair paint with a high-zinc dust content. Welds shall be touched-up with paint conforming to \-SSPC Paint 20-\ in accordance with \-ASTM A 780-\. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

2..3. ADJUSTING PLATES

Adjusting plates or segments of deck units shall be provided in locations too narrow to accommodate full-size units. As far as practical, the plates shall be the same thickness and configuration as the deck units.

2..4. NOT USED

2..5. ACCESSORIES

The manufacturer's standard accessories shall be furnished as necessary to complete the deck installation. Metal accessories shall be of the same material as the deck .

PART 3. EXECUTION

3..1. ERECTION

Erection of deck and accessories shall be in accordance with \-SDI Pub No 28-\ and the approved detail drawings. Damaged deck and accessories including material which is permanently stained or contaminated, with burned holes or deformed shall not be installed. The deck units shall be placed on secure supports, properly adjusted, and aligned at right angles to supports before being permanently secured in place. The deck shall not be used for storage or as a working platform until the units have been secured in position. Loads shall be distributed by appropriate means to prevent damage during construction and to the completed assembly.

3..2. NOT USED

3..3. *ATTACHMENTS*

All fasteners shall be installed in accordance with the manufacturer's recommended procedure, except as otherwise specified. The deck units shall be welded with nominal 5/8 inch diameter puddle welds or fastened with screws, powder-actuated fasteners or pneumatically driven fasteners to supports in accordance with requirements of \-SDI Pub No 28-\. All welding of steel deck shall be in accordance with \-AWS D1.3-\ using methods and electrodes as recommended by the manufacturer of the steel deck being used. Welds shall be made only by operators previously qualified by tests prescribed in \-AWS D1.3-\ to perform the type of work required. Welding washers shall be used at the connections of the deck to supports. Deck ends shall be lapped 2 inches. All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of \-SDI-02-\. Powder-actuated fasteners shall be driven with a low-velocity piston tool by an operator authorized by the manufacturer of the piston tool. Pneumatically driven fasteners shall be driven with a low-velocity fastening tool and shall comply with the manufacturer's recommendations. .

SECTION 06100

ROUGH CARPENTRY

SECTION 06100

ROUGH CARPENTRY

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN FOREST AND PAPER ASSOCIATION (AFPA)

\-AFPA-T901-\	(1991; Supple 1993; Addenda Apr 1995) National Design Specification for Wood Construction
\-AFPA T11-WCD1-\	(1988) Manual for Wood Frame Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 307-\	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
\-ASTM F 547-\	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

\-AWPA C2-\	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
\-AWPA M4-\	(1995) Standard for the Care of Preservative-Treated Wood Products
\-AWPA P5-\	(1995) Standards for Waterborne Preservatives

CALIFORNIA REDWOOD ASSOCIATION (CRA)

\-CRA-RIS-01-SS-\	(1995) Standard Specifications for Grades of California Redwood Lumber

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

\-FM-D.S 1-49-\	(1984) Data Sheet 1-49 Perimeter Flashing

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

\-NHLA-01-\	(1994) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

\-NELMA-01-\ (1993) Standard Grading Rules for Northeastern Lumber

SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

\-SCMA-01-\ (1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

\-SPIB-1001-\ (1994) Standard Grading Rules for Southern Pine Lumber

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

\-WCLIB Std 17-\ (1993) Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

\-WWPA-01-\ (1995; Supple Nos. 1, 2, and 3) Western Lumber Grading Rules 95

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Nailers and Nailing Strips\; *GA*\.

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

1..3. DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

PART 2. PRODUCTS

2..1. LUMBER AND SHEATHING

2..1..1. Grading and Marking

2..1..1..1. Lumber Products

Solid sawn and finger-jointed lumber shall bear an authorized gradestamp or grademark recognized by ALSC, or an ALSC recognized certification stamp, mark, or hammerbrand. Lumber shall be standard or number 2 grade, minimum member size of 2 inches.

2..1..2. Sizes

Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Unless otherwise specified, sizes indicated are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

2..1..3. Treatment

Wood members shall be preservative treated. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with \-AWPA M4-\. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment. Treatment shall be in accordance with \-AWPA C2-\ with waterborne preservatives listed in \-AWPA P5-\ to a retention level of 0.25 pcf.

2..1..4. Moisture Content

At the time lumber and other materials are delivered and when installed in the work their moisture content shall be 15 percent maximum.

2..2. ACCESSORIES AND NAILS

Markings shall identify both the strength grade and the manufacturer. Accessories and nails shall conform to the following:

2..2..1. Anchor Bolts

\-ASTM A 307-\, size as indicated, complete with nuts and washers.

2..2..2. Bolts: Lag, Toggle, and Miscellaneous Bolts and Screws

Type, size, and finish best suited for intended use. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.

2..2..3. Clip Angles

Steel, 3/16 inch thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

2..2..4. NOT USED

2..2..5. NOT USED

2..2..6. NOT USED

2..2..7. Nails

\-ASTM F 547-\, size and type best suited for purpose; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in \-AFPA T11-WCD1-\. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail

capacity tables in \-AFPA-T901-\. Reasonable judgement backed by experience shall ensure that the designed connection will not cause the wood to split.

PART 3. EXECUTION

3..1. INSTALLATION

Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Stacked nailers shall be assembled with spikes or nails spaced not more than 18 inches on center and staggered. Beginning and ending nails shall not be more than 6 inches for nailer end. Ends of stacked nailers shall be offset approximately 12 inches in long runs and alternated at corners. Anchors shall extend through the entire thickness of the nailer. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place. Nailers and nailer installation for Factory Mutual wind uplift rated roof systems specified in other Sections of these specifications shall conform to \-FM-D.S 1-49-\.

TABLE I. SPECIES AND GRADE

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm
\-NHLA-01-\				
	Cypress			X
\-NELMA-01-\				
	Eastern White Pine	X		
	Northern Pine	X		
\-CRA-RIS-01-SS-\				
	Redwood		X	
\-SCMA-01-\				
	Cypress			X
\-SPIB-1001-\				
	Southern Pine		X	
\-WCLIB Std 17-\				
	Douglas Fir-Larch	X		
	Hem-Fir	X		
	Sitka Spruce	X		
	Mountain Hemlock	X		
	Western Cedar	X		
\-WWPA-01-\				
	Douglas Fir-Larch	X		
	Hem-Fir	X		
	Idaho White Pine	X		
	Lodgepole Pine			X
	Ponderosa Pine			X
	Sugar Pine			X
	Englemann Spruce			X
	Douglas Fir South			X
	Mountain Hemlock			X
	Subalpine Fir			X
	Western Cedar			X

SECTION 07220

ROOF INSULATION

SECTION 07220

ROOF INSULATION

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

\-ASTM C 726-\	(1993) Mineral Fiber Roof Insulation Board
\-ASTM C 728-\	(1991) Perlite Thermal Insulation Board
\-ASTM F 547-\	(1977; R 1990) Terminology of Nails for Use with Wood and Wood-Base Materials

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

\-FM P7825-\	(1995; Supple 1; Supple II; Supple III) Approval Guide

UNDERWRITERS LABORATORIES (UL)

\-UL-01-\	(1996) Building Materials Directory

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-06 Instructions\

Application of Insulation\; *FIO*\.

Insulation manufacturer's recommendations for the application and installation of insulation.

SD-08 Statements\

Inspection\; *FIO*\.

The inspection procedure for insulation installation, prior to start of roof insulation work.

1..3. STORAGE OF MATERIALS

Insulation shall be kept dry at all times, before, during, and after delivery to the site and shall be stored in an enclosed building or in a closed trailer. Wet insulation shall be permanently removed from the site.

1..4. FIRE CLASSIFICATION

Insulation shall have been tested as part of a roof construction assembly of the type used in this project and the construction shall be listed as Fire-Classified in \-UL-01-\ or Class I in \-FM P7825-\.

PART 2. PRODUCTS

2..1. NOT USED

2..2. *INSULATION*

Insulation shall be a standard product of the manufacturer and shall be factory marked with the manufacturer's name or trade mark, the material specification number and the thickness. Minimum thickness shall be as recommended by the manufacturer. Boards shall be marked individually. Insulation and fiberboard shall contain the highest practicable percentage of material which has been recovered or diverted from solid waste (e.g., postconsumer waste), but not including material reused in a manufacturing process. Where two materials have comparable price and performance, the one having the higher recovered material content shall be selected. Insulation shall be one, or a combination of the following materials:

2..2..1. NOT USED

2..2..2. NOT USED

2..2..3. Expanded-Perlite Insulation Board

\-ASTM C 728-\ with a minimum recovered material content of 23 percent of the expanded perlite portion of the board.

2..2..4. NOT USED

2..2..5. Mineral-Fiber Insulation Board

\-ASTM C 726-\.

2..3. NAILS AND FASTENERS

Nails and fasteners shall conform to the following requirements:

2..3..1. Nails for Fastening Insulation to Flush Mounted Wood Nailers

\-ASTM F 547-\ of sufficient length to hold insulation securely in place.

2..3..2. Fasteners

Insulation manufacturer's recommendations except holding power, when driven, shall be not less than 120 pounds each in steel deck. Fasteners for steel or concrete decks shall conform to \-FM P7825-\ for Class I roof deck construction, and shall be spaced to withstand an uplift pressure of 90pounds per square foot.

2..3..3. Metal Disks

Flat and not less than 30 gauge thickness. Disks used with nails or fasteners for securing fiberboard insulation shall be minimum l inch diameter. Disks used with nails or fasteners for securing other board insulation shall be minimum 2-1/8 inches in diameter.

2..4. NOT USED

2..5. NOT USED

2..6. NOT USED

2..7. WOOD NAILERS

Wood nailers shall conform to Section \=06100=\ ROUGH CARPENTRY including preservative treatment. Edge nailers shall be not less than nominal 6 inches wide and of thickness to finish flush with the top surface of the insulation. Surface mounted nailers shall be a nominal 3 inches wide by the full thickness of the insulation.

PART 3. EXECUTION

3..1. COORDINATION REQUIREMENTS

Insulation and roofing membrane shall be finished in one operation. Phased construction will not be permitted.

3..2. ENVIRONMENTAL CONDITIONS

Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck when the insulation and roofing are installed.

3..3. SUBSTRATE PREPARATION

The substrate construction of any bay or section of the building shall be completed before insulation or vapor retarder work is begun thereon. Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Substrate surface shall be smooth, clean, and dry at time of application.

3..4. NOT USED

3..5. NOT USED

3..6. INSTALLATION OF WOOD NAILERS

Nailers shall be securely attached to steel decks. Bolt anchors shall have nuts and washers countersunk, and bolts shall be cut flush with top of nailer. Powder-actuated fasteners, sized and spaced for nailer anchorage equivalent to that specified and indicated, may be used when approved. Surface mounted nailers shall be installed parallel with the roof slope and shall be spaced not over 4 feet face-to-face, except that where the insulation units are less than 4 feet in length the nailers shall be spaced to minimize cutting of the insulation.

3..7. *APPLICATION OF INSULATION*

Units of insulation shall be laid in courses parallel with the roof slope. End joints shall be staggered. Insulation shall be cut to fit neatly against adjoining surfaces. Joints between insulation boards shall not exceed 1/4 inch. Joints in successive layers shall be staggered with respect to joints of preceding layer. Where insulation is applied over steel deck, long edge joints shall continuously bear on surfaces of the steel deck.

3..7..1. Mechanical Fastening

The insulation shall be mechanically fastened. Method of attachment shall be in accordance with recommendations of the insulation manufacturer and requirements specified.

3..7..2. Steel Decks

Uninsulated steel decks shall have insulation applied to span the steel deck flutes and to act as an underlayment for the roof membrane. Insulation on steel deck shall be compatible with mechanical fastening.

3..7..3. NOT USED

3..7..4. NOT USED

3..7..5. Protection Requirements

The insulation shall be kept dry at all times. Insulation boards shall not be kicked into position. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces will not be permitted.

3..8. INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roof insulation with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.

b. Verification of certification, listing or label compliance with \-FM P7825-\.

c. Inspection of mechanical fasteners; type, number, length, and spacing.

d. Coordination with other materials, cants, sleepers, and nailing strips.

e. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.

SECTION 07535

MODIFIED BITUMEN ROOFING

SECTION 07535

MODIFIED BITUMEN ROOFING

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM D 312-\	(1995) Asphalt Used in Roofing
\-ASTM D 2824-\	(1994) Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, Asbestos Fibered, and Fibered without Asbestos
\-ASTM D 3746-\	(1985; R 1991) Impact Resistance of Bituminous Roofing Systems
\-ASTM D 4586-\	(1993) Asphalt Roof Cement, Asbestos Free
\-ASTM D 4601-\	(1994) Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
\-ASTM D 5147-\	(1991) Sampling and Testing Modified Bituminous Sheet Material

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

\-FM-04-\	(1996) Approval Guide: Building Materials

UNDERWRITERS LABORATORIES (UL)

\-UL-01-\	(1996; Supple) Building Materials Directory
\-UL 790-\	(1995) Tests for Fire Resistance of Roof Covering Materials
\-UL 1256-\	(1993; Rev thru Apr 1996) Fire Test of Roof Deck Constructions

1..2. SYSTEM DESCRIPTION

The modified bitumen roofing system shall consist of a manufacturer's standard, prefabricated, reinforced polymer-modified bitumen membrane, with base sheet, and insulation as specified and indicated. The manufacturer shall have a minimum of 5 years experience in manufacturing of the proposed modified bitumen sheet roofing for similar applications.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-06 Instructions\

Materials and Installation\; *GA*\.

Manufacturer's instructions, including membrane description and performance data, detailed procedure for installation, and safety precautions, prior to the start of roofing work.

SD-13 Certificates\

Qualifications\; *GA*\.

Evidence that the manufacturer has a minimum of 5 years experience manufacturing modified bitumen roofing. The roofing system applicator shall be approved by the modified bitumen roofing manufacturer, and shall have a minimum of 3 years experience as an approved applicator. A list of installations using the same products and applicator as proposed shall be included.

Materials\; *GA*\.

Certificates of compliance for felts, bitumens, and membrane sheet.

SD-18 Records\

Bills of Lading\; *GA*\.

Bills of lading shall indicate the flash point and equiviscous temperature (EVT) and this information shall be shown on labels for each unit (or plug) of asphalt.

1..4. STORAGE OF MATERIALS

Felts and roofing sheets shall be kept dry before, during, and after delivery to the site. Felts and roofing sheets shall be stored on end one level high, in an enclosed building or trailer and on platforms, off the deck or floor. Felts and sheets shall be maintained at a temperature above 50 degrees F for 24 hours immediately before laying.

1..5. COORDINATION REQUIREMENTS

The work shall be coordinated with other trades to ensure that components are available when they are to be secured or stripped into the roofing system.

1..5..1. Insulation

Application of roofing shall immediately follow application of insulation as a continuous operation.

1..5..2. Flashings

Modified bituminous sheet shall be used for flashings where the roof deck abuts angles, vertical surfaces, edge metal, and penetrations, unless otherwise specified or indicated. Flashing shall be installed as the work progresses.

1..5..3. Sheet Metalwork

Sheet metalwork specified in Section \=07600=\ SHEET METALWORK, GENERAL shall be coordinated with roofing operations.

1..6. ENVIRONMENTAL CONDITIONS

Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck at the time roofing is installed. Roofing shall not be applied when air temperature is less than 20 degrees F. When air temperature is less than 40 degrees F, kettles shall be insulated, felts and sheets shall be kept warm, and the application site shall be protected.

1..7. FLAME HEATED EQUIPMENT

Flame heated kettles shall not be placed on the roof. Torch application shall be approved by the membrane manufacturer for the specific modified bitumen. Open flame equipment shall not be left unattended while ignited.

1..8. ELECTRIC-HEATED EQUIPMENT

Adequate electrical service shall be provided as required by the manufacturer of the equipment, to insure proper application of the roofing materials.

1..9. FIRE AND WIND UPLIFT REQUIREMENTS

The complete roof system shall have a \-UL 1256-\, \-UL 790-\, Class A or B classification, be listed as "fire classified" in \-UL-01-\, and bear the UL label or be listed as a Class I Roof Deck in \-FM-04-\. Roofing system over steel deck shall be rated Class I- 90 in accordance with \-FM-04-\. Ratings from other independent laboratories may be substituted provided that the tests, requirements and ratings are documented to be equivalent, to the satisfaction of the Contracting Officer.

1..10. WARRANTY

Manufacturer's standard warranty for the roofing system shall be provided for not less than 10 years from acceptance of the work. Warranty shall state that manufacturer shall repair or replace defective materials if the roofing system leaks or allows the insulation beneath the membrane to become wet during the period of the warranty.

PART 2. PRODUCTS

2..1. PRIMER

Primer shall conform to \-ASTM D 41-\.

2..2. ASPHALT

Asphalt shall conform to \-ASTM D 312-\, Type III for slopes up to 25 percent (1/4 vertical/horizontal) and Type IV for slopes up to 50 percent (1/2 vertical/horizontal).

2..3. BITUMINOUS CEMENT

Bituminous cement shall conform to \-ASTM D 4586-\.

2..4. CANTS AND WOOD NAILERS

Treated wood cants and wood nailers shall be of water-borne preservative-treated material as specified in Section \=06100=\ ROUGH CARPENTRY. Cants shall be made from treated wood or treated fiberboard not less than 3-1/2 inches high and cut to reduce change in direction of the membrane to 45 degrees or less. Fiberboard shall conform to \-ASTM C 208-\, treated with sizing, wax or bituminous impregnation. When membrane or flashing is to be torch applied, cants shall be fire resistant.

2..5. NOT USED

2..6. MODIFIED BITUMEN SHEET

Modified bitumen sheet shall be a bitumen modified by atactic polypropylene (APP) or styrene butadiene styrene (SBS); or modified by SBS which has been further modified with styrene ethylene butadiene styrene (SEBS). Sheets shall be uniform in thickness and appearance, and free from blisters or tape splices. Sheets shall not stick to the roll or stack, and shall be suitable for joining along the entire length by the procedure recommended by the manufacturer. Sheet shall be reinforced with fiber made from glass, polypropylene, or polyester, and shall meet the following requirements:

MODIFIED BITUMEN SHEET PROPERTIES

Maximum Load/Elongation, \-ASTM D 5147-\ weakest (longitudinal or transverse) direction:

Maximum load, minimum	90 lbf/in.
Elongation, minimum, when reinforced with:	
glass fiber	3 percent
polyester or polypropylene	40 percent
Tear Strength, \-ASTM D 5147-\ Minimum	80 pounds
Low Temperature Flexibility, \-ASTM D 5147-\	SBS: minus 15 degrees F APP: plus 15 degrees F
Impact Resistance, \-ASTM D 3746-\	No Damage

2..7. NAILS AND FASTENERS

Nails and fasteners shall be an approved type recommended by the roofing felt or membrane manufacturer.

2..8. SURFACING MATERIAL

Surfacing shall be factory applied granules requiring no further coating.

2..9. ADHESIVE

Adhesive shall be an approved type recommended by the membrane manufacturer.

2..10. NOT USED

2..11. INSULATION

Insulation shall be compatible with the membrane, as recommended by the membrane manufacturer's printed instructions, and as specified in Section \=07220=\ ROOF INSULATION.

2..12. COATING

Aluminum coating shall conform to \-ASTM D 2824-\ Type I or III, or shall be as recommended by the membrane manufacturer.

PART 3. EXECUTION

3..1. PREPARATION REQUIREMENTS

The substrate construction of any bay or section of the building shall be completed before roofing work is begun thereon. Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Nailers, curbs and other items attached to roof surface shall be in place before roofing is begun.

3..2. INSTALLATION OF CANTS

Cants shall be installed in the angles formed between the roof and walls or other vertical surfaces. Cants shall be laid in a solid coat of bituminous cement just prior to laying the base sheet or membrane. Cants shall be continuous, and shall be installed in lengths as long as practicable.

3..3. CONDITION OF SURFACES

Surfaces shall be inspected and approved immediately prior to application of roofing and flashings. The roofing and flashings shall be applied to a smooth and firm surface free from ice, frost, visible moisture, dirt, projections, and foreign materials.

3..4. MECHANICAL APPLICATION DEVICES

Mechanical application devices shall be mounted on pneumatic-tired wheels, and shall be designed and maintained to operate without damaging the insulation, roofing membrane, or structural components.

3..5. NOT USED

3..6. HEATING OF BITUMEN

Asphalt shall not be heated higher than 75 degrees F above the EVT or 50 degrees F below the flash point or 525 degrees F (maximum) whichever is lower. EVT and flash point temperatures of asphalt in the kettle shall be conspicuously posted on the kettle. Heating kettle shall be provided with automatic thermostatic control and an accurate thermometer. Kettle operators shall be in attendance at all times during the heating to ensure that the maximum temperature specified is not exceeded. An asphalt tanker shall be treated as a kettle.

3..7. BITUMEN APPLICATION

Asphalt shall be applied within 25 degrees F below or above the EVT, or 400 degrees F, whichever is higher. Application temperatures shall be measured at the mop bucket or mechanical applicator. Bitumen at a temperature below the recommended temperature shall be returned to the kettle.

3..8. APPLICATIONS OF BASE SHEET

Base sheet shall be applied, shingle fashion, in a continuous operation, with side laps in accordance with manufacturer's printed instructions. End laps shall be not less than 6 inches and staggered a minimum of 24 inches. Base sheets shall be applied at right angles to the slope (except on curved or steep deck) and laps shall face down the slope. Non venting base sheet shall be applied in hot mopping of not less than 20 pounds nor more than 35 pounds of asphalt per square and shall be embedded in the hot asphalt with a squeegee or broom to eliminate air pockets and assure complete adhesion. Operator shall avoid heavy application of squeegees to glass-fiber sheets.

3..9. MODIFIED BITUMEN MEMBRANE APPLICATION

Membrane shall be one or two plies, as recommended by the membrane manufacturer. Each sheet in each ply shall be fully adhered to the underlying surface. Sheet edges shall lie flat, with no fishmouths or wrinkles. Installation shall begin at the low point of the roof and progress to the high point with each sheet installed shingle fashion. Each sheet shall be unrolled to provide 4 inch side laps and 6 inch end laps. End laps shall be staggered not less than 24 inches. Laps shall not coincide with laps of base layers except at lines of permanent termination.

3..10. NOT USED

3..11. MECHANICAL FASTENING

Nails and fasteners for securing base or membrane sheet to wood nailers or deck shall be flush driven through flat metal disks of not less than 1 inch diameter. Metal disks may be omitted where heads of fasteners are equivalent in size to the 1 inch diameter disks. Screw fasteners with disks as specified by the membrane manufacturer shall be used on concrete or metal deck. Nails and fasteners shall be spaced to meet the wind uplift requirement and within the tolerances specified by the manufacturer. Penetration of nails and fasteners will not be permitted through the exposed surface of membrane.

3..12. NOT USED

3..13. FLASHINGS

Flashings shall be provided over cants, in the angles formed at walls and other vertical surfaces, and where required to make the work watertight. Modified bitumen flashings shall be used, except where metal flashings are specified in other sections of the specifications.

3..14. NOT USED

3..15. NOT USED

3..16. COATING APPLICATION

After roofing membrane has been laid and flashings installed, the roof surface, including cants, shall be coated with an aluminum coating as recommended by the membrane manufacturer.

3..17. FIRE WATCH

Fire watch shall be provided continuously during and for at least 1 hour following torch application. At least two 2-1/2 gallon containers of water and two 15 pound carbon dioxide extinguishers shall be available during the fire watch. When work is interrupted, or at the end of a section of roofing, and at end of each day's work, areas which had been subjected to torch applications shall be surveyed with an infra-red sensing device. Hot spots shall be cooled and re-surveyed. If a hot spot persists, the roof shall be cut open and any smoldering shall be extinguished before the foreman leaves the site.

3..18. NOT USED

3..19. INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roofing with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Inspection shall include, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of roofing workers; start and end time of various tasks; condition of substrate.

b. Verification of compliance of materials before, during, and after installation.

c. Inspection of condition of equipment and accuracy of thermometers and metering devices.

d. Inspection of flashings, cants and curbs.

e. Inspection of membrane placement, including edge envelopes, widths of starter sheets, laps, proper use of squeegee, and mechanical fastening.

f. Inspection of application of bitumen.

SECTION 07600

SHEET METALWORK, GENERAL

SECTION 07600

SHEET METALWORK, GENERAL

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 167-\	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
\-ASTM B 32-\	(1995b) Solder Metal
\-ASTM B 209-\	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
\-ASTM B 221-\	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
\-ASTM B 370-\	(1992) Copper Sheet and Strip for Building Construction
\-ASTM D 226-\	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
\-ASTM D 828-\	(1993) Tensile Breaking Strength of Paper and Paperboard
\-ASTM D 2822-\	(1991) Asphalt Roof Cement
\-ASTM D 4586-\	(1993) Asphalt Roof Cement, Asbestos Free

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

\-ISWA IWS 089-\	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

\-SMACNA-02-\	(1993) Architectural Sheet Metal Manual

1..2. GENERAL REQUIREMENTS

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall allow for expansion and contraction.

1..2..1. Coordination

Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Application of bituminous strip flashing over various sheet metal items is covered in Section \=07510=\ BUILT-UP ROOFING. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Materials\; *GA*\.

Drawings of sheet metal items showing weights, gauges or thicknesses; types of materials; jointing; expansion-joint spacing; fabrication details; and installation procedures. Materials shall not be delivered to the site until after the approved detail drawings have been returned to the Contractor.

1..4. DELIVERY, STORAGE, AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet-storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, ventilated areas until immediately before installation.

PART 2. PRODUCTS

2..1. *MATERIALS*\

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by \-SMACNA-02-\ for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements specified below and to the thicknesses and configurations established in \-SMACNA-02-\. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

2..1..1. Accessories

Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided.

2..1..2. Aluminum Extrusions

\-ASTM B 221-\, Alloy 6063, Temper T5.

2..1..3. Bituminous Cement

Type I asphalt cement conforming to \-ASTM D 2822-\ or \-ASTM D 4586-\. For coal tar roofing; coal tar cement conforming to \-ASTM D 4022-\.

2..1..4. NOT USED

2..1..5. Fasteners

Fasteners shall be compatible with the fastened material and shall be the type best suited for the application.

2..1..6. Felt

\-ASTM D 226-\, Type I.

2..1..7. NOT USED

2..1..8. Aluminum Alloy Sheet and Plate

\-ASTM B 209-\, color _to match existing_ clad, form, alloy, and temper appropriate for use.

2..1..9. Copper

\-ASTM B 370-\, Temper H 00.

2..1..10. Stainless Steel

\-ASTM A 167-\, Type 302 or 304; fully annealed, dead soft temper.

2..1..11. Solder

\-ASTM B 32-\, 95-5 tin-antimony.

2..2. FINISH COLOR

Finish color of exposed sheet metal shall match the sheet metal of the existing adjacent roof.

PART 3. EXECUTION

3..1. GENERAL

Unless otherwise specified or indicated, exposed edges shall be folded back to form a 1/2 inch hem on the concealed side, and bottom edges of exposed vertical surfaces shall be angled to form drips. Bituminous cement shall not be placed in contact with roofing membranes other than built-up roofing.

3..2. NOT USED

3..3. PROTECTION OF ALUMINUM

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods:

3..3..1. Paint

Aluminum surfaces shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint as specified in Section \=09900=\ PAINTING, GENERAL.

3..3..2. Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and cemented to the aluminum surface using a cement compatible with aluminum.

3..4. CONNECTIONS AND JOINTING

3..4..1. Soldering

Soldering shall apply to copper, and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a water solution of washing soda and rinsed with clean water.

3..4..2. Riveting

Joints in aluminum sheets 0.040 inch or less in thickness shall be mechanically made.

3..4..3. Seaming

Flat-lock and soldered-lap seams shall finish not less than 1 inch wide. Unsoldered plain-lap seams shall lap not less than 3 inches unless otherwise specified. Flat seams shall be made in the direction of the flow.

3..5. NOT USED

3..6. CLEATS

A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints of cleats shall be spaced approximately 1/8 inch apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry. The cleat for fascia anchorage shall be installed to extend below the supporting construction to form a drip and to allow the flashing to be hooked over the lower edge at least 3/4 inch. The cleat shall be of sufficient width to provide adequate bearing area to insure a rigid installation.

3..7. NOT USED

3..8. NOT USED

3..9. GRAVEL STOPS AND FASCIA

Gravel stops and fascia shall be fabricated and installed as indicated and in accordance with \-SMACNA-02-\. Sheets shall be fabricated without longitudinal joints except where two-piece fasciae are used when fascia depth exceeds 7 inches. Provision for expansion shall be provided at joints. Factory fabricated internal and external corner units with mitered joints shall be provided. Roof /flange and splice plate of the gravel stop and fascia shall extend out on the roof not less than 4 inches, and shall be set in bituminous cement over the roofing felt. Roof flange shall be secured with nails spaced not greater than 3 inches on centers located within 1 inch of the outer edge of the flange. The fascia section shall not be face nailed except as specified for two-piece fasciae. The upper piece of two-piece fascia shall be the same as specified above except that the fascia depth shall be at least 3-1/2 inches, and it shall overlap the lower fascia not less than 2 inches. The lower piece shall be hooked 1/2 inch over edge strip and splice plate and face nailed on 12-inch centers 1 inch below top of sheet. The upper fascia shall be hemmed 1/2 inch at lower edge and shall be formed to fit tight against lower fascia. Either smooth or corrugated sheets may be used.

3..9..1. Extrusions

The extruded type of aluminum gravel stop and fascia shall be a factory fabricated, prepackaged, complete system with fastenings, of the style indicated. The system shall be installed in accordance with the manufacturer's recommendations and the other requirements herein specified.

3..9..2. Sheets, Smooth

Gravel stops shall be installed with 1\2-inch space between sections. The cover plate shall be embedded in bituminous cement, nailed through the opening between the gravel stop sections and loose locked to the drip edge. The lower edge of fascia shall be hooked 3/4 inch over a continuous cleat and bent outward at an angle of 30 degrees.

SECTION 09900

PAINTING, GENERAL

SECTION 09900

PAINTING, GENERAL

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

\-ACGIH-02-\	(1996) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM D 4214-\	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
\-ASTM D 4258-\	(1983; R 1992) Surface Cleaning Concrete for Coating

FEDERAL SPECIFICATIONS (FS)

\-FS TT-C-542-\	(Rev E) Coating, Polyurethane, Oil-Free, Moisture Curing
\-FS TT-P-19-\	(Rev D) Paint, Latex (Acrylic Emulsion, Exterior Wood and Masonry)
\-FS TT-P-38-\	(Rev E) Paint, Aluminum (Ready-Mixed)
\-FS TT-P-645-\	(Rev B) Primer, Paint, Zinc-Molybdate, Alkyd Type

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC Paint 5-\	(1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint
\-SSPC Paint 25-\	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)
\-SSPC Paint 26-\	(1991) Slow Drying Linseed Oil Black Maintenance Primer (Without Lead and Chromate Pigments)
\-SSPC SP 1-\	(1982) Solvent Cleaning
\-SSPC SP 2-\	(1995) Hand Tool Cleaning

\-SSPC SP 3-\ (1995) Power Tool Cleaning

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Paint\; *FIO*\.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular batch is 50 gallons or less.

SD-06 Instructions\

Mixing and Thinning\; *FIO*\.

Application\; *FIO*\.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature.

SD-13 Certificates\

Lead\; *FIO*\.

Volatile Organic Compound (VOC) Content\; *FIO*\.

Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-14 Samples\

Paint Chip Samples\; *GA*\

The Contractor shall furnish three coated cards for each coating proposed for use which shows the actual color, gloss, and general appearance of the material. Each color card shall be identified by the Federal Specification number or manufacturer's number, and intended use. The color card shall be no smaller than 3 x 5 inches.

1..3. PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer.

Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1..4. NOT USED

1..5. ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 50 and 90 degrees. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

1..6. SAFETY AND HEALTH

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1..6..1. Worker Exposures

Exposure of workers to hazardous chemical substances shall not exceed limits as established by \-ACGIH-02-\, or as required by a more stringent applicable regulation.

1..6..2. Toxic Compounds

Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the Contracting Officer.

1..6..3. Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MSDS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1..6..4. Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

PART 2. PRODUCTS

2..1. *PAINT*\

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the respective specifications listed for use in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 50 gallons or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2..1..1. Colors and Tints

Colors shall match the colors of the existing adjacent roof structure and concrete slab, as appropriate. The color of the undercoats shall vary slightly from the color of the next coat.

2..1..2. NOT USED

2..1..3. *Lead*\

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2..1..4. Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2..1..5. *Volatile Organic Compound (VOC) Content*\

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3. EXECUTION

3..1. PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3..2. SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primmed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3..2..1. Concrete Surfaces

Concrete surfaces shall be allowed to dry at least 90 days before painting. Surfaces shall be cleaned in accordance with \-ASTM D 4258-\. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3..2..2. Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with \-SSPC SP 1-\. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to \-SSPC SP 2-\, power tools according to \-SSPC SP 3-\ or by sandblasting according to \-SSPC SP 7-\. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3..2..3. Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with \-SSPC SP 1-\.

3..3. *MIXING AND THINNING*

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3..4. *APPLICATION*

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry

film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3..4..1. NOT USED

3..4..2. Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3..4..3. First Coat

The first coat shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application.

3..4..4. Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3..4..5. NOT USED

3..4..6. NOT USED

3..4..7. NOT USED

3..4..8. Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

3..5. NOT USED

3..6. NOT USED

3..7. SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

3..8. SURFACES NOT TO BE PAINTED

Surfaces of hardware, fittings, and other factory finished items shall not be painted. If the metal roof decking is galvanized, do not paint.

3..9. CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3..10. PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by ------or------ between optional systems or coats.

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Concrete:	\-FS TT-C-542-\	\-FS TT-C-542-\	None
Wood, unless otherwise specified.	\-FS TT-P-19-\	\-FS TT-P-19-\	\-FS TT-P-19-\
Ferrous metal unless otherwise specified.	\-SSPC Paint 5-\	\-FS TT-P-38-\	\-FS TT-P-38-\
Galvanized metal.	\-FS TT-P-19-\	\-FS TT-P-19-\	\-FS TT-P-19-\
Aluminum aluminum-alloy, and other non-ferrous metal (non-galvanized)	\-FS TT-P-645-\	\-FS TT-E-489-\,	\-FS TT-E-489-\

SECTION 13120A

METAL BUILDINGS

SECTION 13120A

METAL BUILDINGS

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

\-AA-01-\	(1993) Aluminum Standards and Data
\-AA SAS-30-\	(1986) Aluminum Construction Manual Series - Section 1 Specifications for Aluminum Structures

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

\-AISC-S329-\	(1986) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts
\-AISC-S335-\	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

\-AISI SG-673-\	(1987) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 325-\	(1994) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
\-ASTM A 446-\	(1993) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
\-ASTM A 463-\	(1994) Steel Sheet, Aluminum-Coated by the Hot-Dip Process
\-ASTM A 490-\	(1993) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
\-ASTM A 792-\	(1993a) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process, General Requirements
\-ASTM B 209-\	(1993) Aluminum and Aluminum-Alloy Sheet and Plate

\-ASTM C 518-\	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
\-ASTM E 84-\	(1994a) Surface Burning Characteristics of Building Materials

AMERICAN WELDING SOCIETY (AWS)

\-AWS D1.1-\	(1994) Structural Welding Code - Steel

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

\-MBMA-01-\	(1986; Errata; Supple 1990) Low Rise Building Systems Manual

UNDERWRITERS LABORATORIES (UL)

\-UL 580-\	(1994; Rev thru Apr 1995) Tests for Uplift Resistance of Roof Assemblies

1..2. GENERAL

1..2..1. Building Configuration

Buildings shall have single-slope roofs. Roof slope shall match the slope of the adjacent connecting roof structure . The roof framing shall accommodate a Built-Up type of roofing system. Buildings shall be single-span structures with one of the following framing systems: continuous beam frames or rigid frame. Knee braces may be used however cross bracing shall not be allowed.

1..2..2. Manufacturer

Metal building shall be the product of a recognized metal building systems manufacturer.

1..2..3. Installer

Erector shall have specialized experience in the erection of metal buildings for a period of at least 3 years.

1..3. DESIGN REQUIREMENTS

1..3..1. Design Conditions

Loading criteria, loading combinations and definitions shall be in accordance with \-MBMA-01-\.

1..3..1..1. Dead Load

The dead load shall consist of the weight of the structural frame and all other materials of the building system.

1..3..1..2. NOT USED

1..3..1..3. Roof Live Loads

Roof live loads shall be determined and applied in accordance with \-MBMA-01-\. A minimum roof live load of 20 psf shall be used for design.

1..3..1..4. Roof Snow Loads

The design roof snow loads shall be in accordance with \-MBMA-01-\.

1..3..1..5. Wind Loads

Wind pressures shall be computed and applied in accordance with \-MBMA-01-\ .

1..3..2. NOT USED

1..3..3. Framing and Structural Members

Structural steel members and their connections shall be designed in accordance with \-AISC-S335-\. Structural cold-formed steel framing members and their connections shall be designed in accordance with \-AISI SG-673-\. The allowable live load deflection of roof elements shall not exceed 1/180th of the span. Members with openings in their webs shall be designed with consideration of the additional stresses which will result due to the openings.

1..4. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Metal Building\; *GA1*\.

Detail drawings consisting of catalog cuts, design and erection drawings containing ; shop painting and finishing specifications, instruction manuals, manufacturer's recommended erection methods and procedures and other data as necessary to clearly describe design, material, sizes, layouts, construction details, fasteners, and erection. Manufacturer's recommended erection methods and procedures shall describe the basic sequence of assembly, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components. A brief list of locations where buildings of similar design have been used shall be included with the detail drawings and shall include information regarding date of installation, name and address of owner, and how the structure is used.

SD-13 Certificates\

Metal Building\; *GA*\.

A certificate from the metal building manufacturer stating that the metal building was designed from a complete set of the contract drawings and

specifications and that the building furnished complies with the specified requirements.

Mill certification for structural bolts, framing steel, and roof deck .

1..5. DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry. Storage accommodations for roof decking shall provide good air circulation and protection from surface staining.

PART 2. PRODUCTS

2..1. BUILDING COMPONENTS

Each piece or part of the assembly shall be clearly and legibly marked to correspond with the detail drawings. Except as specified herein all components shall be metal building manufacturer's standard materials.

2..2. ROOF DECK

Design provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Decking shall designed to support the built-up roofing deadload and roof liveloads and shall be factory primed for painting or galvanized. Decking is specified in section \=05300=\ STEEL DECKING. Wood nailers for roofing are specified in Section \=06100=\ ROUGH CARPENTRY. Roofing and Insulation for roofing are specified in Section \=07504=\ ROOF INSULATION AND BUILT-UP ROOFING. Roof Fascia, flashings and trim are specified in Section \=07600=\ SHEET METALWORK, GENERAL

2..3. SHOP PRIMING

Ferrous surfaces shall be cleaned of oil, grease, loose rust, loose mill scale, and other foreign substances and shop primed. Primer coating shall be in accordance with the manufacturer's standard system.

PART 3. EXECUTION

3..1. ERECTION

Erection shall be in accordance with the approved erection instructions and drawings and with applicable provision of \-AISC-S335-\. The completed buildings shall be free of excessive noise from wind-induced vibrations under the ordinary weather conditions to be encountered at the location where the building is erected, and meet all specified design requirements. Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to \-AWS D1.1-\; welding of aluminum shall conform to \-AA SAS-30-\. High-strength bolting shall conform to \-AISC-S329-\ using \-ASTM A 325-\ or \-ASTM A 490-\ bolts. Concrete work is specified in Section \=03300=\ CONCRETE FOR BUILDING CONSTRUCTION.

3..2. FIELD PAINTING

Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Shop-primed ferrous surfaces exposed on the outside of the building shall be painted with two coats of an approved exterior enamel. Factory color finished surfaces shall be touched up as necessary with the manufacturer's recommended touch-up paint.

SECTION 15050

MECHANICAL EQUIPMENT, FUELING

SECTION 15050

MECHANICAL EQUIPMENT, FUELING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata) Pipe Flanges and Flanged Fittings
\-ASME B40.1-\	(1991) Gauges--Pressure Indicating Dial Type--Elastic Element
\-ASME-16-\	(1992; Addenda Dec 1992, Dec 1992, Dec 1994) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1

AMERICAN PETROLEUM INSTITURE (API)

\-API BULL 1529-\	(1989) Aviation Fueling Hose

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM C 827-\	(1987) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
\-ASTM A 48-\	(1983; R 1990) Gray Iron Castings
\-ASTM A 536-\	(1984) Ductile Iron Castings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 30-\	(1990) Flammable and Combustible Liquids Code
\-NFPA 70-\	(1996) National Electric Code

MILITARY SPECIFICATIONS (MS)

\-MS MIL-C-4556-\	(Rev. E, 1990) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
\-MS MIL-P-24441-\	(Rev. B, 1991; Supp. 1) General Specification for Paint, Epoxy - Polyamide
\-MS MIL-T-83133-\	(Rev. C, 1990; Amend. 1) Turbine Fuels, Aviation, Kerosene Types, NATO F-34(JP-8) and NATO F-35

MILITARY STANDARDS (MIL-STD)

\-MIL-STD-130-\	(Rev. G, 1988) Identification Marking of U.S. Military Property
\-MIL-STD-161-\	(Rev. F, 1985; Notice 2) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE AMS 3275A-\	(1994) Acrylonitrile Butadiene (NRB) Rubber Sheet, Non-Asbestos Fiber Fuel and Oil Resistant

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having and "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Pressure Gages\; *GA*\ (Para. 2.5).

Flow Switch\; *GA*\ (Para. 2.8).

Product Recovery Tank and Accessories\; *GA*\ (Para. 2.10).

Air Eliminator Tank and Equipment\; *GA*\

Manufacturer's Catalog Data

Product Recovery Tank\; *GA*\.

Air Eliminator Tank and Equipment\; *GA*\.

Provide the design analysis as one package with detail drawings. The design analysis shall be signed by a Registered Professional Engineer shall include a list of the design loads, and complete calculations for the vault.

SD-04 Drawings\

Product Recovery Tank\; *GA*\.

Air Eliminator Tank and Equipment\; *GA*\.

Provide the drawings as one package with the design analysis. Shop fabrication drawings shall include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings shall also show the steel grating and supports.

SD-09 Reports\

Test Reports

SD-13 Certificates\.

Coating Products\; *GA*\.

U.L. Labeled products\; *GA*\.

Certificates of Compliance

SD-19 Operating and Maintenance Manuals\.

Pressure Gauges\; *GA*\.

Product Recovery Tank and Accessories\; *GA*\.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Components shall be suitable for use with JP-8 turbine fuel; specific gravity 0.81 at 60 degrees F., viscosity 1.62 CS at 60 degrees F., Reid vapor pressure less than 0.05 psi, \-MS MIL-T-83133-\. Components to be ANSI Class 150 (275 PSIG at 100 degrees F.) unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between 10 degrees F. and 100 degrees F.

2.2 COMPOSITION OF MATERIALS

Materials in contact with the fuel shall be noncorrosive. No zinc-coated metals, brass, bronze, or other bearing alloys shall be used in contact with the fuel.

2.3 ELECTRICAL WORK

Motors, manual or automatic motor control equipment except where installed in motor control centers, and protective or signal devices required for the operation specified herein shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR.

2.4 MATERIALS AND EQUIPMENT

All items of material and equipment shall be new and of the best quality used for the purpose in commercial practice and shall be products of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded. Equipment, assemblies and parts shall be marked for identification in accordance with \-MIL-STD-130-\ and \-MIL-STD-161-\. Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter, and marking

shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

2.4.1 Supplier

The Contractor's attention is directed to the fact that the pump control system, including but not limited to control panel, air eliminator tank and level sensors, and control valves with all hardware and software is an integrated system, shall be furnished by a single systems supplier regularly engaged in the supplying of this equipment. Supplier shall provide all equipment and appurtenances regardless of manufacture, and be responsible to the Contractor for satisfactory operation of the entire system. Substitutions of functions specified will not be acceptable. The Contractor shall coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system.

2.5 *PRESSURE GAGES*

Pressure gages shall conform to \-ASME B40.1-\ with metal cases and 4-inch diameter white dials. Gages shall be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, shall be provided for each gage. Range of gages shall be as indicated. A ball valve shall be provided for each pressure gage. Gages shall have all parts immersed in silicone oil.

2.6 GASKETS

Gaskets shall be in accordance with Section \=15060=\ PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM.

2.7 BOLTS AND NUTS

Bolts and nuts shall be in accordance with Section \=15060=\ PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM.

2.8 Flow Switches

Switches shall be actuating vane type flow switch with single adjustable set-point. Switches shall mount on \-ASME B16.5-\ Class 150 raised face flange. Provide snap action switch mechanism U.L. listed for Class I, Division 1, Group D hazardous locations. Switches to be double pole double throw (DPDT). Switch power shall be 120 volts, single phase, 60 hertz, 10 amps minimum.

2.9 PRODUCT RECOVERY TANK

Each system shall include tank, and all necessary pipe, valves, and fittings.

2.9.1 Tank

The tank shall be a 20-gallon fabricatedsteel tank with supporting legs as shown. The interior and exterior surfaces of the tank shall be coated for corrosion protection. The surfaces shall be coated in accordance with \-MS MIL-P-24441-\, Formulas 150, 151, and 152.

2.9.2 Sight Glass

Sight glasses for tank shall be standard tubular gages with density ball and shut-off valves on each end. Wetter parts other than sight glass shall be stainless steel. If glass breakage should occur, a stainless steel ball in the valve shall close preventing product loss. Glass shall be protected by minimum of four guard rods.

2.9.3 Anchoring

All units of the system shall be installed plumb and level and secured in place by anchor bolts.

2.10 AIR ELIMINATOR TANK

2.10.1 Tank Housing

Each Tank housing shall be fabricated from carbon steel and shall be internally coated with an epoxy coating in accordance with \-MS MIL-C-4556. Coat the exterior with alkalyal resin primer (universal metal primer). Each unit shall be constructed and labeled in accordance with \-ASME 16-\. The housing shall be designed for a working pressure of 90 psig. The inlet and outlet connections shall be provided with raised face flanges faced and drilled in compliance with \-ASME B16.5-\, Class 150. The configuration of the air eliminator tanks shall be as shown on the drawings.

2.10.2 Sight Gauge

A ½-inch armored, clear pyrex liquid level gauge shall be provided for observing fuel level in the tank. The gauge shall be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball. Glass shall be protected by a minimum of four guard rods.

2.10.3 High Level Shutoff

The vent connection shall have a stainless steel high level shutoff mechanism to act as an overfill prevention device to keep fuel from going out the vent.

2.10.4 Level Sensors

The level sensors shall be ultrasonic tip sensitive level control switches, \-NEMA 7/9-\, weatherproof, explosion proof for Class I, Div I, Group D, temperature T2D (419E F.), 120-volt input power, DPDT relay output, 1-inch flanged mounting.

2.10.5 Vent

Tank vent outlet shall be equipped with pressure-vacuum breather vent, aluminim construction with weather hood and with viton pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at ½ oz per square inch, and vacuum relief set at 32 oz per square inch. Pressure venting capacity shall be 5400 cubit feet per hour, vacuum capacity shall be 5000 cubic feet per hour.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.2 Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

3.1.3 Grouting

Equipment which is anchored to a pad shall be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting shall be in accordance with \-ASTM C 827-\. Perform all grouting in accordance with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.1.4 Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a spirit level across the half faces. Radially align shafts by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.001 inch tolerance, except as other-wise required by more stringent requirements of equipment manufacturer.

3.2 POSTED OPERATING INSTRUCTIONS

For each designated system or equipment item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

3.2.1 Each System

For each system, include diagrams of equipment, piping, wiring and control. Define control sequences.

3.2.2 Each Item

For each equipment item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of equipment failure. Provide other instructions recommended by the manufacturer.

3.2.3 Diagrams

The Contractor shall provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram shall be 36 inches x 54 inches and shall be color coded to match PCP color diagrams. Diagram shall show the entire facility and shall include all equipment and the operational sequences of all equipment with equipment numbers displayed. Diagram shall

show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It shall be wall mounted under glass.

SECTION 15060

PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM

SECTION 15060

PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI Z49.1-\	(1988) Safety in Welding and Cutting

AMERICAN PETROLEUM INSTITUTE (API)

\-API SPEC 5L-\	(1995) Line Pipe
\-API SPEC 6D-\	(1994) Pipeline Valves (Gate, Plug, Ball, and Check Valves)
\-API RP 6FA-\	(1994; R 1990; Supple) Fire Test for Valves
\-API STD 607-\	(1993) Fire Test for Soft-Seated Quarter-Turn Valves
\-API STD 608-\	(1995) Ball Valves
\-API RP 1110-\	(1991) Pressure Testing of Liquid Petroleum Pipeline

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME-16-\	(1992; Addenda Dec 1992, Dec 1992, Dec 1994) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels DIVISION 1
\-ASME-17-\	(1992; Addenda Dec 1992, Dec 1993, Dec 1994) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
\-ASME B1.1-\	(1989) Unified Inch Screw Threads (UN and UNR Thread Form)
\-ASME B16.5-\	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
\-ASME B16.9-\	(1993) Factory-Made Wrought Steel Buttwelding Fittings

\-ASME B16.11-\	(1991) Forged Fittings, Socket-Welding and Threaded
\-ASME B16.21-\	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
\-ASME B18.2.1-\	(1981; R 1992) Square and Hex Bolts and Screws Inch Series
\-ASME B18.2.2-\	(1987) Square and Hex Nuts (Inch Series)
\-ASME B31.1-\	(1995) Power Piping
\-ASME B31.3-\	(1990; B31.3a-1990; Errata; B31.3b-1991) Chemical Plant and Petroleum Refinery Piping

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM A53-\	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
\-ASTM A105-\	(1996) Forgings, Carbon Steel, for Piping Components
\-ASTM A181-\	(1995b) Carbon Steel Forgings, for General Purpose Piping
\-ASTM A182-\	(1996e) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
\-ASTM A193-\	(1996b) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
\-ASTM A194-\	(1996) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
\-ASTM A234-\	(1996a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
\-ASTM D229-\	(1991) Rigid Sheet and Plate Materials Used for Electrical Insulation
\-ASTM E94-\	(1991) Radiographic Testing
\-ASTM F436-\	(1991) Hardened Steel Washers

AMERICAN WELDING SOCIETY (AWS)

\-AWS A2.4-\	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination

\-AWS A3.0-\	(1989) Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying and Thermal Cutting
\-AWS A5.1-\	(1991) Carbon Steel Electrodes for Shielded Metal Arc Welding
\-AWS A5.4-\	(1981) Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Electrodes
\-AWS A5.5-\	(1981) Low-Alloy Steel Covered Arc Welding Electrodes

FEDERAL SPECIFICATIONS (FS)

\-FS L-C-530-\	(Rev C) Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
\-FS L-T-1512-\	(Rev A; Reinst) Tape, Pressure Sensitive Adhesive, Pipe Wrapping

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C62.41-\	(1991) Surge Voltages in Low-Voltage AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

\-MSS SP-58-\	(1988) Pipe Hangers and Supports-Materials, Design and Manufacture
\-MSS SP-69-\	(1991) Pipe Hangers and Supports-Selection and Application

MILITARY SPECIFICATIONS (MS)

\-MS MIL-C-4556-\	(Rev E) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
\-MS MIL-V-12003-\	(Rev F; Am 1) Valves Plug: Cast Iron or Steel, Manually Operated
\-MS MIL-S-13789-\	(Rev D) Strainers, Sediment: Pipeline, Basket Type
\-MS MIL-P-24441-\	Paint, Epoxy-Polyamide, General Specification for Paint, Epoxy-Polyamide

MILITARY STANDARDS (MIL-STD)

\-MIL-STD-161-\	(Rev F; Notice 2) Bulk Petroleum Products System Including Hydrocarbon Missile Fuels
\-MIL-STD-271-\	(Rev F) Nondestructive Testing Methods

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 30-\ (1990) Flammable and Combustible Liquids Code

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE J 514-\ (1989) Hydraulic Tube Fittings, Standard

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC SP 5-\ (1991) White Metal Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

\-UL 1449-\ (1996) Transient Voltage Surge Suppressors

1.2 SUBMITTALS

In accordance with the Section 01330, the Contractor shall submit for approval the following items required by this section.

SD-01 Data\

Piping\; *GA*\.

Fittings\; *GA*\.

Valves\; *GA*\.

Strainers\; *GA*\.

Flexible Hoses\; *GA*\.

Lightning Surge Arrester\; *GA*\.

(Coating)

Sample Connections\; *GA*\.

Isolating Gasket Kits\; *GA*\.

Gaskets\; *GA*\.

Purge Blocks\; *GA*\.

Manufacturer's Catalog Data

SD-08 Statements\

Qualifications of Welders\; *FIO*\.

SD-09 Reports\

Pneumatic Test\; *FIO*\.

Hydrostatic Test\; *FIO*\.

SD-13 Certificates\

Pipe\; *FIO*\.

Fittings\; *FIO*\.

Valves\; *FIO*\.

Pipe Weld Radiograph Inspector's Certification\; *FIO*\ (for field welds).

Epoxy Coating and Application\; *FIO*\.

Isolating Gasket Kits\; *FIO*\.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\.

Operation and maintenance information shall be submitted for the equipment items or systems listed below. Refer to Section \=01730=\ FACILITY OPERATION AND MAINTENANCE MANUAL for the information to be submitted for various type of equipment and systems.

Manual Valves
Strainers
Sample Connections
Isolating Gasket Kits
Gaskets
Flexible Hoses

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Design conditions shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING SYSTEM.

2.2 MATERIALS

2.2.1 General

Pipe and fittings in contact with fuel shall be carbon steel. No zinc coated metals, brass, bronze or other copper bearing alloys shall be used in contact with the fuel. Identification of piping shall be in accordance with \-MIL-STD-161-\ unless specified otherwise. Material for manual valves shall be as specified hereinafter.

2.2.2 Carbon Steel Piping

Each length of pipe shall be subjected to hydrostatic testing and ultrasonic testing in accordance with their respective pipe specification.

a. Piping 12-Inches and Larger: Seamless, ASTM A53 Grade B having a wall thickness of 0.375-inch.

b. Piping 2 1/2-Inches through 10-Inches: Seamless, Schedule 40 API SPEC 5L Grade B or ASTM A53 Grade B.

c. Piping Two-Inches and Smaller: Seamless, Schedule 80 API SPEC 5L Grade B or ASTM A53 Grade B.

d. Welding Electrodes: E70XX low hydrogen electrodes conforming to \-AWS A5.1-\ or \-AWS A5.5-\.

2.2.3 Protective Coatings for Aboveground Carbon Steel Piping

Provide painting of aboveground piping, piping in pits, pipe supports, air eliminators, and miscellaneous metal and equipment in accordance with MS MIL-P-24441. Color of finish coat shall be white. Do not paint stainless steel or aluminum surfaces.

2.2.4 Fittings

2.2.4.1 General

Welding ells, caps, tees, reducers, etc., to be of materials compatible for welding to the pipe line in which they are installed, and wall thickness, pressure and temperature ratings of the fittings shall be not less than the adjoining pipe line. Unless otherwise required by the conditions of installation, all elbows shall be the long radius type. Miter joints shall not be acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings to be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted.

2.2.4.2 Carbon Steel Fittings

a. Fittings 2 1/2 Inches and Larger: Butt weld, conforming to \-ASTM A234-\, grade WPB and \-ASME B16.9-\ of the same wall thickness as the adjoining pipe. All welds shall be radiographically examined throughout the entire length of each weld. Each fitting shall be subjected to the Supplementary Requirements S3 and S4, Liquid Penetration examination and Magnetis-Particle Examination. Detectable flaws will not be accepted in the supplementary examinations. Fittings shall be identified to relate them to their respective radiograph.

b. Fittings 2 Inches and Smaller. Forged (socket welded or if indicated on drawings, threaded), 2,000-pound W.O.G., conforming to \-ASTM A105-\, Grade 2 and \-ASME B16.11-\. Threaded fittings shall only be used for above grade applications.

c. Flanges: One-hundred-fifty-pound weld neck, forged flanges conforming to \-ASTM A181-\, Grade 2, and \-ASME B16.5-\. Flanges to be 1/16-inch raised face with phonographic finish, except where required otherwise to match equipment furnished. Match flange face to valves or equipment furnished. Flange face shall be machined to match valves or equipment furnished. Use of spacing rings or gaskets discs are not allowed. Flanges shall be subjected to the Supplementary Requirements S4 and S5, Liquid Penetrant Examination, and Magnetic-Particle Examination. Detectable flaws will not be accepted.

2.2.4.3 Isolating Gasket Kits (Insulating) for Flanges

Provide \-ASTM D229-\ electrical insulating material of 1,000 ohms minimum resistance; material shall be resistant to the effects of aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges. Provide full surface 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Exterior above grade flanges separated by electrically isolating gasket kits shall be provided with weatherproof lightning surge arrester devices. The surge arrester shall bolt across flanges separated by insulating gasket kits per detail on contract drawings. The arrestor shall have the following features:

a. Weatherproof NEMA 4 enclosure.
b. Bidirectional and bipolar protection.
c. Constructed of solid state components, no lights, fuses or relays shall be used that will require maintenance or replacement.
d. Withstand unlimited number of surges at 50,000 Amperes.
e. Maximum clamping voltage of 700 Volts based on a \-IEEE C62.41-\ 8x20 mircosecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule.

Line Size (Inches)	Bolt Size (Inches)
2	5/8
2-1/2	5/8
3	5/8
4	5/8
6	3/4
8	3/4
10	7/8
12	7/8
14	1
16	1

(Note: Allowance must be made for the 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.)

2.2.5 Bolts and Nuts

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories shall conform to \-ASME B18.2.1-\ and \-ASME B18.2.2-\, except as otherwise specified. Bolts shall be of sufficient length to obtain full bearing on the nuts and shall project no more than two full threads beyond the nuts with the bolts tightened to the required torque. Bolts shall be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to \-ASTM A193-\, Class 2, Grade B8. Bolts shall be threaded in accordance with \-ASME B1.1-\, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Nuts shall conform to \-ASME B18.2.2-\, hexagonal, heavy series with material conforming to \-ASTM A194-\, Grade 8. Nuts shall be threaded in accordance with \-ASME B1.1-

\, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Provide washers under bolt heads and nuts. Washers to be \-ASTM F436-\, flat circular stainless steel. Torque wrenches shall be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern shall be as recommended by the gasket manufacturer.

2.2.6 Gaskets

\-ASME B16.21-\, composition ring 0.1250-inch thick. Gaskets shall be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets shall be used for flat-face flanged joints. Ring gaskets shall be used for raised-face flanged joints. Gaskets shall be of one piece factory cut.

2.2.7 Relief and Drain System Piping

Pressure relief valve discharge lines and drain lines shall be Schedule 40 \-API SPEC 5L-\ Grade B or \-ASTM A53-\ Grade B Carbon Steel.

2.2.7.1 Gaskets

See Gaskets specified hereinbefore.

2.2.8 Relief and Drain System Protective Coating

Pipe shall be coated as specified hereinbefore for steel piping.

2.2.9 Threaded Joints

Threaded joints, if indicated on the drawings, shall be made tight with manufacturer recommended teflon tape or a mixture of graphite and oil, inert filler and oil, or with a graphite compound, applied with a brush to the male threads. Not more than three threads shall show on made up joints. Threaded joints, mechanical couplings and flanges will not be permitted in buried piping. Threaded joints shall not get welded.

2.2.10 Welded Joints

Welded joints in steel pipe shall be as specified in Part 3 "EXECUTION."

2.3 MANUAL VALVES

Stem and trim shall be stainless steel for all valves. Manually operated valves six inches and larger shall be worm-gear operated and valves smaller than six inches shall be wrench operated. Valves smaller than two inches shall have lever-type handles.

2.3.1 Ball Valves

Ball valves shall be fire tested and qualified in accordance with the requirements of \-API STD 607-\ and \-API STD 608-\. Ball valves shall be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves two inches and larger shall conform to applicable construction and dimension requirements of \-API SPEC 6D-\, ANSI Class 150 and shall have flanged ends. Valves smaller than 2 inches shall be

ANSI class 150 valves with one piece bodies with flanged ends, unless noted otherwise. The balls in valves 10 inches and larger shall have trunion type support bearings. Except as otherwise specified, reduced port or full port valves may be provided at the Contractor's option.

2.3.1.1 Materials

Ball shall be stainless steel. Ball valves shall have tetraflouroethylene (TFE) or Viton seats, body seals and stem seals.

2.3.2 Plug (Double Block and Bleed) Valves

\-API SPEC 6D-\ and \-MS MIL-V-12003-\ Type III, ANSI Class 150, non-lubricated, resilient, double seated, trunion mounted, tapered lift plug capable of two-way shutoff. Valve shall have stainless steel or carbon steel body with chrome-plated interior, tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunions. Sealing slips shall be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design shall permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves shall have weatherproof operators with mechanical position indicators. Minimum bore size shall be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design.

2.3.2.1 Valve Operation

Rotation of the handwheel toward open shall lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed shall lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips shall form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits shall be provided with handwheel extensions.

2.3.2.2 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves shall open at 25 psi differential pressure and shall discharge to the throat of, and to the side of the plug valve as indicated on the drawings.

2.3.2.3 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.3.3 Check

Valve shall be swing type conforming to \-API Spec 6D-\ regular type. Check valves shall be tilting disc, nonslam type. Discs and seating rings shall be renewable without removing from the line. The disc shall be guided and controlled to contact the entire seating surface.

2.4 RELIEF VALVES

Relief valves shall be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and shall be labeled in accordance with \-ASME-16-\. Valve stems shall be fully guided between the closed and fully opened positions. The valves shall be factory-set to open at the set pressure indicated on the drawings. Operating pressure shall be adjustable by means of an enclosed adjusting screw. The valves shall have a minimum capacity of 20 GPM at 10 percent overpressure and shall operate at rated capacity with a back pressure not exceeding 50 psi. Valves shall have a replaceable seat.

2.4.1 Materials

Valves shall have carbon steel bodies and bonnets with stainless steel springs and trim. Valves shall be Class 150 flanged end connections.

2.4.2 Sight Flow Indicators

Sight flow indicators shall be ANSI Class 150 and shall have flanged end connections. Sight flow indicators shall consist of a housing containing a rotating propeller that is visible through a glass observation port. The housing shall be carbon steel. The glass in the indicator shall also meet the Class 150 rating.

2.5 PIPING ACCESSORIES

2.5.1 Strainers

2.5.1.1 Basket Type

Strainer shall be in compliance with \-MS MIL-S-13789-\, except as specified otherwise. Strainer end connections shall be designed in accordance with \-ASME B16.5-\, Class 150. Strainers shall have stainless steel bodies, stainless steel shall be Types 304 or 316. Strainers shall have removable baskets of 60 mesh wire screen with larger wire mesh reinforcement; wire shall be stainless steel, Type 316. Pressure drop for clean strainer shall not exceed three psig at design flow rate. The ratio of net effective strainer area to the area of the connecting pipe shall be not less than three to one. Each strainer shall be provided with a suitable drain at the bottom, equipped with a ball valve. Strainer shall be the single inlet, single outlet design. Strainer shall be supplied with a piston type direct reading differential pressure gage as specified in \=Section 15880=\ FILTER SEPARATOR.

2.5.1.2 Cone Type (Temporary)

Strainer shall be stainless steel type 304 or 316, 60 mesh screen with the ratio of net open area of strainer to the area of the connecting pipe shall be not less than one to one.

2.5.2 Pipe Hangers and Supports

2.5.2.1 General

Pipe hangers and supports shall conform to \-MSS SP-58-\ and \-MSS SP-69-\. Supports shall be provided at the indicated locations. Support channels for drain lines shall be epoxy coated on all surfaces or hot-dip galvanized after the channels are cut to length. Coated supports shall be coated with fusion bonded epoxy resin applied by the fluidized bed method. Thickness of the coating shall be not less than 10 mils. Surface preparation and coating application shall be in accordance with the epoxy manufacturer's instructions. The coating shall be pinhole free when tested with a low voltage holiday detector set at no more than 100 times the mil thickness of the coating. All pinholes shall be marked, repaired and retested to ensure a pinhole free film. The coating material shall be a 100 percent solids, thermosetting, fusion-bonded, dry powder epoxy resin. The manufacturer shall certify that the material is suitable for fluidized bed application and that it is approved by the Environmental Protection Administration.

2.5.2.2 Adjustable Pipe Supports

Adjustable pipe supports shall consist of a cast iron saddle and a threaded nipple connected to a carbon steel pipe by means of a special reducer conforming to \-MSS SP-69-\. The supports shall be provided with neoprene insulation strips.

2.5.2.3 Low Friction Supports

Low friction supports shall be self-lubricating antifriction element composed of reinforced TFE. Units shall be factory designed and manufactured.

2.5.2.4 Concrete and Grout

Concrete and grout for anchors and supports shall comply with \=SECTION 03300A=\ CONCRETE FOR BUILDING CONSTRUCTION.

2.5.3 Sample Connections

Sample connections shall be factory assembled units specifically designed for obtaining representative samples from fuel pipelines. Each connection shall include a 1/4-inch sampling probe where the probe faces upstream, ball valve and 1/4-inch quick disconnect coupling with dust plug, all assembled into a unit that is suitable for installation in a pipe nipple. The sampling probe shall extend not less than one inch into the fuel pipe. All materials in the sample connections shall be stainless steel or aluminum.

2.5.3.1 Sampling Hoses

Furnish two sampling hose assemblies to the Contracting Officer at the project site. Each assembly shall consist of a six-foot length of 1/4-inch clear plastic tubing with internal bonding/grounding wire. One end of the tubing will contain a male connector that actuates flow when inserted into the quick disconnect coupler. Each end of the bonding/grounding wire shall be equipped with clips for attaching to the pipe and metal sample container.

2.6 FLEXIBLE HOSES

Flexible hoses for fueling pumps shall have ANSI Class 300 flanges of stainless steel construction conforming to \-ASME B16.5-\. Flexible hoses shall be of stainless steel flexible metal hose consisting of an inner corrugated stainless steel tube with stainless steel braid cover. All components to be suitable for not less than 275 psig. Length and application of flexible hoses shall be per manufacturer's written recommendations.

PART 3 EXECUTION

3.1 WELDING

3.1.1 General

All joints unless indicated otherwise, shall be welded. Unless otherwise approved, all girth welds shall be complete penetration groove welds made in accordance with qualified welding procedures. Welding operations, qualifications of welders and welding procedures shall comply with the provisions of \-ASME B31.3-\ and the requirements specified herein. The root pass on carbon steel pipe shall be by MIG or TIG.

a. Definitions shall be in accordance with \-AWS A3.0-\.

b. Symbols shall be in accordance with \-AWS A2.4-\ for welding and nondestructive testing, unless otherwise indicated.

c. Safety Precautions shall conform to \-ANSI Z49.1-\.

d. Weld Preparation shall comply with the requirements of \-ASME B31.3-\ and the qualified Welding Procedure Specification. The use of "rice paper" as purge blocks is not permitted. Contractor shall submit alternate method for approval.

e. Backing Rings. The use of backing rings for making or repairing welds will not be permitted.

3.1.2 Qualifications of Welders

Welders and welding procedures shall be qualified in accordance with requirements of \-ASME B31.3-\.

3.1.2.1 Weld Identification

Each qualified welder shall be assigned an identification symbol. All welds shall be permanently marked with the symbol of the individual who made the weld.

3.1.2.2 Defective Work

Welders found making defective welds shall be removed from the work or shall be required to be requalified in accordance with \-ASME B31.3-\.

3.1.3 Tests

All field welds shall be examined by radiographic methods to determine conformance to the paragraph "Standards of Acceptance." The services of a qualified commercial or testing laboratory approved by the Contracting Officer

shall be employed by the Contractor for testing of piping welds. Costs of testing, including retesting or repaired welds, shall be borne by the Contractor.

3.1.3.1 Radiographic Inspection

Procedures for radiographic inspection shall be in accordance with \-MIL-STD-271-\ or \-ASTM E94-\. Weld ripples or surface irregularities that might mask or be confused with the radiographic image of any objectional defect shall be removed by grinding or other suitable mechanical means. The weld surface shall be merged smoothly with the base metal surface.

3.1.4 Standards of Acceptance

Interpretation of test results and limitations on imperfections in welds shall comply with the requirements for "100 percent Radiography, per \-ASME B31.3-\, Chapter VII, Table K341.3.2A.

3.1.5 Corrections and Repairs

Defects shall be repaired in accordance with approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Whenever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. After a defect is thought to have been removed, and prior to rewelding, the area shall be examined by suitable methods to insure that the defect has been eliminated. After repairs have been made, the repaired area shall be reinspected and shall meet the standards of acceptance for the original weld. Any indication of a defect shall be regarded as a defect unless reevaluation by nondestructive methods and/or by surface conditioning shows that no defect is present.

3.1.5.1 Defect Removal

Defective or unsound weld joints shall be corrected by removing and replacing the entire weld joint, or for the following defects corrections shall be made as follows:

a. Excessive Convexity and Overlap: Reduce by removal of excess metal.

b. Excessive Concavity of Weld, Undersized Welds, Undercutting: Clean and deposit additional weld metal.

c. Excessive Weld Porosity, Inclusions, Lack of Fusion, Incomplete Penetration: Remove defective portions and reweld.

d. Crack in Weld or Base Metal: Remove crack throughout its length, including sound weld metal for a distance of twice the thickness of the base metal or two inches, whichever is less, beyond each end of the crack, followed by the required rewelding. Complete removal shall be confirmed by magnetic particle inspection for carbon steel or liquid penetrant inspection for stainless steel. Inspection procedures shall comply with the requirements of \-ASME B31.3-\.

e. Poor Fit-Up: Cut apart improperly fitted parts, and reweld.

3.1.5.2 Methods of Defect Removal

The removal of weld metal or portions of the base metal shall be done preferably by chipping, grinding, sawing, machining, or other mechanical means. Defects also may be removed by thermal cutting techniques. If thermal cutting techniques are used, the cut surfaces shall be cleaned and smoothed by mechanical means.

3.1.5.3 Rewelding

Repair welds shall be made using an electrode or filler wire preferably smaller than that used in making the original weld. Rewelding shall be done using qualified welding procedures. The surface shall be cleaned before rewelding. Repair welds shall meet the requirements of this specification.

3.1.5.4 Peening or Caulking

The use of force (peening) or foreign materials to mask, fill in, seal, or disguise any welding defects shall not be permitted.

3.2 INSTALLATION

3.2.1 Precautions

Special care shall be taken by the Contractor to insure that the completed system is free of rocks, sand, dirt, and foreign objects. The Contractor shall take the following steps to insure these conditions.

a. Pipe brought to the site shall be stored on blocks or horses at least 18 inches above the ground. Padded blocks or horses shall be used for coated pipe. The method and height of storing coated pipe shall be in accordance with the coating manufacturer's instructions.

b. Visual inspection shall be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

c. The open ends of the pipe system shall be closed at the end of each day's work or when work is not in progress and shall not be opened until the work is resumed.

d. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, shall be pulled through each length of pipe after welding in place.

e. Obstruction remaining in the pipe after completion of the system shall be removed at the expense of the Contractor.

3.3 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3.4 CLEANING OF PIPING

The Contractor shall keep the interior and ends of all new piping affected by the Contractor's operations thoroughly cleaned of foreign matter and water

before and after being installed. Piping systems shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings shall be closed so that no water or other foreign substance will enter the pipes or fittings. Piping shall be inspected before placing into position. The interior of each length of pipe shall be cleaned after welding. It shall be the Contractor's responsibility for insuring that the interior of the piping is free of foreign matter when it is connected into the system.

3.5 PIPING LAYOUT REQUIREMENTS

3.5.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system.

3.5.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.5.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of equipment, valves and gauges.

3.5.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.5.5 Piping and Equipment

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide hangers and supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space hangers uniformly and arrange symmetrically.

3.5.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure.

3.5.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within ± 1/4-inch over the entire length of pipe.

3.5.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. In lieu of welding reducing outlet tees for piping 2 inches and larger, welding branches suitable for 100 percent radiographic inspection may be used. Do not use weldolets unless specifically called out (labeled) on the drawings.

3.5.9 Direction Changes

Make changes in the horizontal direction of pipes with long radius fittings. Provide special fittings when required. Do not make miter welds. Make odd-angle offsets with pipe bends or elbows cut to the proper angle.

3.6 TESTING

Piping shall be tested by pneumatic and hydrostatic pressure. Testing shall comply with applicable requirements of \-ASME B31.3-\, \-NFPA 30-\ and the requirements specified herein. Hydrostatic testing shall be performed using fuel as the liquid. Water shall not be introduced into the system for testing. Pressure and hydrostatic testing shall be performed only after welding inspection has been completed.

3.6.1 General

Piping to be installed underground shall not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, the Contractor shall isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line shall be closed by means of blind flanges in lieu of relying on the valve. The Contractor shall furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor and/or pressurizing pump. No taps in the permanent line will be permitted. The Contractor shall furnish all necessary equipment for testing; all gauges shall be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing shall have a residual humidity of not over 20 percent. The Contractor shall provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump shall not exceed 10 cfm.

3.6.1.1 Pneumatic Test Procedure

Special safety measures, including the wearing of face mask, shall be taken during testing under pressure. Only authorized personnel shall be permitted in the area during testing. The pneumatic test pressure shall be applied in increments. A preliminary 25 psig test shall be applied. Examine joints with soap solution. Leaks revealed by this test shall be repaired. The full test pressure shall then be applied. Unless otherwise directed by the Contracting Officer, all piping shall be tested at a pressure of 50 psig for not less than 2 hours, during which time there shall be no drop in pressure, only pressure rises with temperature. The pressure source shall be disconnected during the final test period. Any leaks revealed by the test shall be repaired and the test repeated.

3.6.1.2 Hydrostatic Test Procedure

Upon completion of pneumatic testing and after backfilling, hydrostatically test each piping system with fuel at 200 psig in accordance with \-ASME B31.3-\ and \-API RP 1110-\, with no leakage or reduction in gauge pressure for four hours. The Contractor shall furnish electricity, instruments, connecting devices, and personnel for test. Fuel shall be furnished by the Government. Defects in work provided by the Contractor shall be corrected by him at his own expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

3.6.2 Performance Testing

The completed fuel system shall be cleaned and performance tested as specified in Section \=15899=\ SYSTEM START UP, FUELING SYSTEM. All control valves, both manual and automatic, shall be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

SECTION 15101

CONTROL VALVES, FUELING SYSTEM

SECTION 15101

CONTROL VALVES, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata) Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM A 194/A 194M-\	(1996) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High Temperature Service
\-ASTM A 216/A 216M-\	(1993) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
\-ASTM A 269-\	(1996) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
\-ASTM A 320/A 320M-\	(1994a, R1995) Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service
\-ASTM A 743/A 743M-\	(1995) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
\-ASTM B 26/B 26M-\	(1992a) Standard Specification for Aluminum Alloy Sand Castings
\-ASTM D 751-\	(1989) Standard Test Method for Coated Fabrics
\-ASTM D 2000-\	(1990) Standard Classification System for Rubber Products in Automotive Applications

MILITARY SPECIFICATIONS (MS)

\-MS MIL-A-8625-\	(1989; Rev E, Am. 1) Anodic Coatings, for Aluminum and Aluminum Alloys
\-MS MIL-I-17563-\	(1985; Rev B) Impregnants for Aluminum, Copper, Iron, Magnesium and Zinc Alloy Castings

MILITARY STANDARDS (MIL-STD)

\-MIL-STD 276-\	(1956; Basic) Impregnation of Porous NonFerrous Metal Castings

NATIONAL FIRE PROTECTION AGENCY (NFPA)

\-NFPA 70-\	(1996) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE J 200-\	(1991) Classification System for Rubber Materials
\-SAE J 429-\	(1983) Mechanical and Material Requirements for Externally Threaded Fasteners

1.2 AVAILABILITY

Control valves specified herein shall be of one manufacturer. The valve manufacturer shall also produce the hydraulically-operated pilots.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Control Valves\; *GA*\

For each type control valve required and specified, submit sectional drawings of main valve and control pilot systems.

SD-01 Data\

Control Valves\; *GA*\

For each type control valve required and specified, submit the following:

a. Flow diagrams.

b. Operational description of the control valve and pilot control system.

c. Complete valve assembly list of materials, along with material Certificates of Conformance, used in the manufacture of the control valves and pilot systems.

SD-13 Certificates\

Previous Air Force/Military Projects\; *GA*\

Qualified Engineers\; *GA*\

Field Assistance\; *GA*\

Provide the following:

a. Proof of experience on previous Air Force/Military projects.

b. Number of qualified (factory trained) engineers available to provide startup support.

c. Written assurance as to ability to respond to specified time for field assistance.

SD-09 Reports\

Control Valves\; *FIO*\

Before shipment, each individual control valve shall be operationally tested and adjusted by manufacturer under actual flow conditions utilizing a hydrocarbon test fluid with a specific gravity comparable to JP-8 fuel. Manufacturer shall submit certified records of test data.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\

Operation and maintenance information shall be submitted for each individual type control valve specified herein.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING. Components to be suitable for ANSI Class 150 (275 psig at 100 degrees F.).

2.2 CONTROL VALVE CONSTRUCTION

2.2.1 General

Control valves shall be single-seated globe type, diaphragm actuated, hydraulically operated valves. Valves shall consist of three (3) major components: the valve body, valve cover, and diaphragm assembly. The diaphragm assembly shall be the only moving part. In the event of diaphragm failure, valve shall fail closed against flow, unless otherwise indicated. The main valve shall be drip-tight when closed. Each valve shall have an external indicator to show the position of the valve disc at all times. Control valves shall be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials which come in contact with the fuel shall be resistant to the effects of and not harmful to aircraft engine fuel and shall be aluminum or stainless steel unless noted otherwise. Materials for control valves, and items to be mounted on the valves shall be as follows:

2.2.1.1 Bodies, Bonnets, and Covers

Shall be constructed of one of the following materials:

a. Aluminum conforming to \-ASTM B 26/B 26M-\, Type 356-T6 anodized in accordance with \-MS MIL-A-8625-\, Type II and surface coated in accordance with \-MIL-STD 276-\/\-MS MIL-I-17563-\.

b. Cast steel conforming to \-ASTM A 216/A 216M-\, Grade WCB internally plated with chromium, nickel or internally electroless nickel plated.

c. Cast stainless steel conforming to \-ASTM A 743/A 743M-\.

d. Bodies shall have flanged inlet and outlet connections. Valve shall have a screwed bottom drain plug.

2.2.1.2 Valve Seats

Shall be stainless steel in accordance with \-ASTM A 743/A 743M-\. It shall be possible to remove the valve seat while the valve is connected in the line. Valve seat and upper stem bearing shall be removable and screwed in the body and/or cover. The lower stem bearing must be concentrically contained in the valve seat and shall be exposed to flow on all sides. The diameter of the valve seat shall be the same size as the inlet and/or outlet flanges of the main valve.

2.2.1.3 Valve Discs

Shall contain a resilient, synthetic rubber disc conforming to \-ASTM D 2000-\ (SAE J 30200) having a rectangular cross section, contained on three and one-half (3-1/2) sides by a disc retainer and a disc guide, forming a drip tight seal against the seat. The disc shall be usable on either side. The disc guide shall be the contoured type capable of holding disc firmly in place during high differential pressure conditions that may develop across the seating surface. The disc retainer shall be capable of withstanding rapid closing shocks.

2.2.1.4 Diaphragm Assembly

Shall form a sealed chamber in the upper portion of the valve, separating the operating fluid from the line pressure. The diaphragm assembly shall contain a valve stem which is fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. Valve body and cover shall be sealed by the diaphragm. Valve stem shall be stainless steel. The bearing material shall be compatible with the fuel specified and shall not contain zinc coated metals, brass, bronze, or other copper bearing alloys. The diaphragm shall be of a nonwicking material or design, with a minimum of two (2) layers of nylon fabric bonded with a minimum of three (3) layers of synthetic rubber (valves 2-1/2 inches and smaller one layer of nylon fabric). The edge area of the center hole for the valve stem shall be sealed by vulcanization. Materials to be resistant to aromatics of up to 50 percent in accordance with \-ASTM D 2000-\ (\-SAE J 200-\). The diaphragm must have a MULLINS-burst rating according to \-ASTM D 751-\ of a minimum of 600 psi per layer of nylon fabric. All diaphragm sizes must be cycle tested to a minimum of 100,000 cycles, by alternately applying pressure under the diaphragm (main valve pressure) and above the diaphragm (cover chamber pressure). That test shall be certified by the manufacturer. The diaphragm shall not be used as a seating surface. The diaphragm must be fully supported by the body and cover in either the open or closed position.

2.2.1.5 Bolts, Screws and Nuts

a. For Cast Aluminum and Cast Steel Body Valves.

(1) Bolts and Screws, cadmium plated steel in accordance with \-SAE J 429-\, Grade 5.

(2) Nuts, cadmium plated steel in accordance with \-ASTM A 194/A 194M-\, Grade 2 H.

b. For Stainless Steel Body Valves. Bolts, Screws and Nuts, \-ASTM A 320/A 320M-\, Grade B8M C.1.1.

2.2.1.6 Pilot Control System and Auxiliary Piping

Shall be stainless steel, seamless, fully annealed tubing conforming to \-ASTM A 269-\, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be 0.049-inch.. All screwed connections shall be made by conic unions (NPT). Tubing connections shall not be welded or sealed with O-ring.

2.2.1.7 Pilot Valves

Shall have stainless steel bodies conforming to \-ASTM A 743/A 743M-\ with stainless steel internal working parts. Disc and diaphragm assemblies shall be as specified herein before. The setting of adjustable type pressure operated pilot valves shall be easily adjusted by means of a single adjusting screw. The adjusting screw shall be protected by a threaded cap drilled to accommodate a lead-seal wire and a lock nut shall be provided on the adjusting screw to lock it in position at the desired setting. The lead seal wire shall be installed after final acceptance of the system.

2.2.1.8 Solenoids

Solenoids for operation of pilot valves shall be housed in an explosion-proof case suitable for Class I, Division 1, Group D with maximum temperature rating of ("T2D" -419 degrees F), hazardous locations as defined in \-NFPA 70-\. Solenoids shall operate on 120 volts, 60 cycle, single phase, alternating current. A manual type operator or needle valve to bypass the solenoid valve shall be provided for emergency manual operation.

2.2.2 Serviceability of Main Valve Internal Parts

Main valve movable parts including strainers, valve seat, stem bearings, and control system shall be replaceable without removing the main valve from the line. All nonmetallic parts shall be replaceable.

2.2.3 Total Lengths

The total valve length does not include the orifice plate flange (when used). If the control valve being supplied has the orifice plate built into its flange, the spacer provided shall bring the valve face-to-face dimension equal to those listed below plus 0.0875 of an inch. The lengths of the valves shall be equal for the following materials: cast stainless steel, cast steel and cast aluminum.

SIZE	VALVE LENGTH

INCHES	(INCHES)
1-1/2	8.5
2	9.375
3	12
4	15
6	20
8	25.4
10	29.8
12	34
14	39
16	41.375

Tolerance shall be ±0.030 of an inch for size one and one-half inches (1-1/2") through eight inches (8") and ±0.060 on an inch for size 10 thru 16 inches.

Control valves not meeting these face to face dimensions shall be supplied with spacers suitable for the proper installation of the valve.

2.2.4 Flanges

	MATERIAL	SEALING SURFACE
A:	Cast Steel, \-ASME B16.5-\ Class 150	Raised Face
B:	Cast Stainless Steel, \-ASME B16.5-\ Class 150	Raised Face
C:	Cast Aluminum, Suitable for minimum working pressure of 275 psig at 100 degrees F.	Flat Face

The mating flange shall be made the same as above.

2.2.5 Identification

2.2.5.1 Main Valve Body

The following shall be cast into the main valve body:

a. Pressure Class
b. Size
c. Material
d. Foundry Heat Number and Identification
e. Manufacturer
f. Flow Pattern

2.2.5.2 Main Valve Cover

The following shall be cast into the main valve cover:

a. Size
b. Material
c. Foundry Heat Number and Identification

2.2.5.3 Brass Name Plates

Brass name plates shall be fastened to the valve. Body name plates shall list the following:

a. Size
b. Model Number
c. Stock Number
d. Manufacturer/Supplier
e. Manufacturer's Inspection Stamp

2.2.5.4 Inlet Name Plate

Inlet name plate shall list the following:

a. Size
b. "Inlet" Marking
c. Assembly Model Number
d. Part Number

2.2.5.5 Outlet Name Plate

Outlet name plate shall list the "Outlet" Marking.

2.2.5.6 Pilot Valves

Pilot valves shall be tag identified.

2.3 MATERIALS

The type of materials which come in contact with the fuel, if not specified hereinbefore, shall be noncorrosive.

2.4 INDIVIDUAL CONTROL VALVE OPERATIONAL REQUIREMENTS

Operation, performance, and special features of the individual control valves shall be as specified herein.

2.4.1 Air Block/Check Valve (CV-1 THRU CV-4)

2.4.1.1 Size

Four-inch (4").

2.4.1.2 Flow

0-640 GPM.

2.4.1.3 Operation

Backpressure control pilots will cause main valve to modulate to maintain constant inlet pressure. There shall be three backpressure control pilots, A, B, and C. Pilot A shall be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 600 gpm. Pilot B shall be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 300 gpm. Pilot C is not solenoid controlled and is set at pressure corresponding with unloading pump flow rate of 150 gpm. All pilots are to have 20-200 psig range.

2.4.1.4 Speed Control

Valve shall open slowly. Opening speed shall be adjustable from two (2) to 30 seconds without affecting closing of valve. Factory set for 15 seconds. The valves shall fail closed against reverse flow in check condition.

2.4.1.5 Check Valve Feature

Valve closure to be rapid, closing quickly when outlet pressure exceeds inlet pressure.

2.4.1.6 Solenoid Control

Solenoid control valves shall be as indicated on the drawings.

2.4.1.7 Strainer

A 40-mesh, stainless steel wire, self-cleaning strainer shall be provided in the pilot valve supply piping.

2.4.2 Receiving Filter Separator Control Valve (FSCV-1 Thru FSCV-3)

2.4.2.1 Size

Six-inch (6")

2.4.2.2 Flow

600 GPM

2.4.2.3 Operation

Filter Separator Control Valve shall limit flow to 600 GPM. Controlling to be by orifice. Rate of flow to be manually adjustable.

2.4.2.4 Check Valve Feature

Valve shall close rapidly when outlet pressure exceeds inlet pressure.

2.4.2.5 Water Slug Shut-Off

Valve shall close rapidly when water is sensed at filter separator sump high level as indicated by Float Control Valve float position. Manual testing of operation shall be possible.

2.4.3 Issue and Receiving Filter Separator Float Control Valve with Manual Tester (FC-1 THRU FC-3)

2.4.3.1 Operation

Float shall ride on the fuel-water interface inside filter separator sump. Activation shall initiate water slug shutoff of filter separator valve.

2.4.3.2 Float Control Pilot and Tester

The filter separator housing sump shall be fitted with a float control pilot valve assembly made of stainless steel. The pilot valve is connected to the filter separator control valve. An integral float control tester shall provide a means to remove a portion of the float ball ballast allowing the float to rise, verifying operation of the water slug and flow control valve, the integrity of the float ball.

PART 3 EXECUTION

3.1 VALVE TESTING AND START-UP SUPPORT

The Contractor shall provide the services of a factory trained and certified service engineer employed by the valve manufacturer to verify that each valve has been properly installed and to verify valves were factory operationally tested, adjusted and set per these specifications. The service engineer shall assist the Contractor in the valve start-up adjustment process and will remain on site until all control valves function as required by the contract documents.

3.1.1 Standard 1-Year Warranty Period

If a problem attributable to the valve's manufacturer or installation arises after the initial system start-up has been accomplished, and after system final acceptance date, the Contractor shall have 48 hours from the time of notification that a problem exists to solve the problem. The problem shall be solved to the satisfaction of the Contracting Officer, the Base Civil Engineer and/or the Command Fuel Facilities Engineer . If the Contractor cannot effectuate a proper resolution to the problem as outlined above in the 48 hour period, the Contractor shall provide a factory trained engineer from the manufacturer of the valve within 48 hours after the expiration of the Contractor's initial 48 hour period to effectuate a resolution of the problem above. All services provided by the valve manufacturer shall be at no cost to the Government. When it has been determined by the Contractor, Contracting Officer, and the valve manufacturer's representative that the valve(s) cannot be repaired in its installed position in the fuel system, it shall be replaced with a new valve and pilot assembly within 48 hours after the initial 96-hour period listed above expires and at no cost to the Government.

3.2 TRAINING

The manufacturer shall conduct one four- (4-)hour training classes for Liquid Fuels Maintenance Technicians which include valve overhaul procedures, pilot overhaul procedures, valve adjustments, and valve diagnostics. The manufacturer shall provide a four-inch (4") valve mock-up with various trim components (i.e., rate of flow, solenoid control, and speed control features) to be used during training. The four-inch (4") valve mock-up shall become the property of the Government and shall be turned over to the Contracting Officer.

SECTION 15140

PUMPS, FUELING SYSTEM

SECTION 15140

PUMPS, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES.

The publication listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only:

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

\-AFBMA 7-\	(1988) Shaft and Housing Fits for Metric Radial Ball and Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata-Oct 1988) Pipe Flanges and Flanged Fittings

AMERICAN PETROLEUM INSTITUTE (API)

\-API STD 610-\	(1995) Centrifugal Pumps for General Refining Service

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A182/A182M-\	(1996e) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service
\-ASTM A276-\	(1996) Stainless Steel Bars and Shapes
\-ASTM A356/A356M-\	(1996) Heavy-Walled, Carbon Low Alloy, and Stainless Steel Castings or Steam Turbines
\-ASTM A487/A487M-\	(1993) Steel Casing for Pressure Service
\-ASTM A582/A582M-\	(1995b) Free-Machining Stainless Steel Bars
\-ASTM A743/A743M-\	(1995) Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
\-ASTM C827-\	(1987) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

HYDRAULIC INSTITUTE (HI)

\-HI-01-\	(1983; 14th Ed.) Standard for Centrifugal, Rotary, and Standard Reciprocating Pumps

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE Std 112-\ (1996) Test Procedure for Polyphase Induction Motors and Generators

MILITARY SPECIFICATIONS (MS)

\-MS MIL-P-24441-\ (1991; Rev. B, Supp. 1) Paint Epoxy - Polyamide, General Specification for

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA MG 1-\ (1993; Rev 1) Motors and Generators

NATIONAL FIRE PROTECTION AGENCY (NFPA).

\-NFPA 70-\ (1996) National Electrical Code

STEEL STRUCTURES PAINTING COUNCIL (SSPC).

\-SSPC PA 1-\ (1991) Paint Application Specification No. 1 Shop, Field, and Maintenance Painting

\-SSPC SP 10-\ (1991) Surface Preparation Specification No. 10 Near-White Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having and "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Transfer Pump (TP-1 through TP-4)\; *GA*\; *MEEL*\

SD-04 Drawings\

Transfer Pump (TP-1 through TP-4)\; *GA*\

SD-13 Certificates\

Transfer Pump (TP-1 through TP-4)\; *GA*\

SD-09 Reports\

Certified Test Curves\; *FIO*\

Hydrostatic, performance, and NPSH tests shall be conducted at the factory on each pump in accord with Hydraulic Institute Standard for Centrifugal, Rotary and Reciprocating Pumps. Test each pump with the actual motor which will drive the pump in the field. Test reports shall bear the serial number of both pump and driver. Submit manufacturer's certified reports of hydrostatic, performance, and NPSH tests. Submit manufacturer's certified test curve. All tests shall be observed by the Contracting Officer or his designated representative. The Contractor shall give the Contracting Office 14 days notice prior to conductance of factory tests in order to schedule observing of factory test.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\

Operation and maintenance information shall be submitted for the pumps and appurtenance specified herein.

1.2.1 Submittal Sequence

Performance testing shall not occur prior to acceptance of shop drawing submittal.

1.3 ELECTRICAL WORK

Motors, manual or automatic motor control equipment except where installed in motor control centers, and protective or signal devices required for the operation specified herein shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Motors shall be high efficiency type and in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUEL SYSTEM.

TRANSFER PUMPS (TP-1 through TP-4)

2.1.1 Capacity

Capacity shall be 600 gpm against a total head of 385 feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum of 60 percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shut-off head shall have a 10 percent to 20 percent head rise to shut off. Pump shall be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps shall not overheat or be damaged in any way while operating continuously at a minimum flow condition of 150 gpm and continuously at a maximum flow condition of 125 percent required capacity GPM. The unit will also be required to operate at a flow of 12.5 percent required capacity GPM without exceeding the vibration limits given in \-API STD 610-\. These pumps are for parallel operation and shall have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.1.2 General Requirements

The pumps for this service shall meet the requirements of \-API STD 610-\, latest edition. Whenever the information contained herein conflicts with said standard, the information here in shall govern. The pumps for this service shall run at a nominal 3600 rpm and shall be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, with end suction and top vertical discharge. Pumps shall be of the back pull-out design to permit removing case half from rear for access to internal parts

without disturbing the suction or discharge piping or the driver. All parts shall be factory inspected so that parts are interchangeable. Pumps and motors shall be furnished as complete units as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.

2.1.2.1 The pump shall require no more than 11-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 600 gpm at rated head and speed. A hydrocarbon reduction or correction factor shall not be used. Pump suction specific speed shall be less than 12,000.

2.1.2.2 The pump shall be horizontal, single stage, single suction with double volute construction to assure radial balance. It shall be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping.

2.1.2.3 The pump case shall be end suction, centerline discharge type for ease of piping alignment. Flange ratings shall be class 300-pound per \-ASME B16.5-\. The case shall be designed for maximum discharge pressure at pumping temperature but not less than 550 psig, with a minimum corrosion allowance of 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces shall be backfaced or spotfaced for positive bolt seating. The radial case to cover split shall be a metal-to-metal fit with a confined, controlled compression gasket.

2.1.2.4 The pump cover shall contain a stuffingbox designed to accept an unbalanced mechanical seal. The stuffingbox shall have a minimum of three-inch studs for seal gland bolting. The gasket fit for seal gland to stuffingbox shall be of the controlled compression type with metal-to-metal joint contact.

2.1.2.5 Both case and cover are to be fitted with renewable wear rings.

2.1.2.6 The impeller shall be of the enclosed type, dynamically and hydraulically balanced. It shall be key driven, held in place by a positive lock, threaded against rotation. The running clearance between the impeller and case-cover wear rings shall be no less than .018-inches.

2.1.2.7 Mechanical Seal. A single unbalanced mechanical seal per \-API STD 610-\ code USTFM of multiple spring design shall be supplied. The seal gland shall be taped for three connections and each shall be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder shall be provided to minimize leakage on complete seal failure.

2.1.2.8 Bearing Housing. Oil lubricated anti-friction, radial and thrust bearings of standard design shall be supplied. The bearings shall be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Bearings shall be retained on the shaft and fitted into housings in accordance with \-AFBMA 7-\. Locking of the ball thrust bearing to the shaft shall be by series W tank type washer. Minimum spacing between bearing centerlines shall be 6.5-inches.

2.1.2.9 A sight glass for checking oil level with a permanent indication of proper oil level shall be supplied.

2.1.2.10 Bearing housings shall be equipped with labyrinth type end seals and deflectors where the shaft passes through the housing; lip-type seals shall not be used. Deflectors shall be made of non-sparking material. The deflector design shall effectively retain oil in the housing and prevent entry of foreign material into the housing.

2.1.2.11 Shafts shall be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It shall be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor shall be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve shall be provided to calculate the factor.

2.1.2.12 A replaceable hooked-type shaft sleeve, locked in place by the impeller shall extend under the mechanical seal and gland.

2.1.2.13 A spacer coupling shall be supplied. The spacer length shall permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings shall be properly keyed in place. Cylindrical fits shall be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 shall be used in selecting couplings based on manufacturer's ratings.

2.1.2.14 Removable coupling guards of the non-sparking type shall be supplied. They shall comply with the requirements of OSHA.

2.1.2.15 Total indicated shaft runout at coupling end shall be 0.001-inches or less. Total shaft deflection shall be no more than 0.002-inches at face of stuffingbox.

2.1.2.16 Baseplate

The baseplate shall be of fabricated steel construction. It shall be of the drain pan style, sloping from back to front. Connections for a drain shall be tapped (1-inch minimum) at the pump end and located to accomplish complete drainage. A grout hole of at least 8-inches minimum diameter shall be supplied and shall have 1/2-inch minimum raised lip edge.

2.1.2.17 Materials

No zinc, brass, bronze or other copper bearing alloy shall come in contact with the fuel.

2.1.2.18 The case and cover shall be constructed of stainless steel \-ASTM A487/A487M-\ GR CF8M or \-ASTM A487/A487M-\ GR CA6NM or aluminum \-ASTM A356/A356M-\ GR T6.

2.1.2.19 Impeller material shall be stainless steel \-ASTM A487/A487M-\ GR CF8M or \-ASTM A743/A743M-\ CA 6NM.

2.1.2.20 Wear rings shall be stainless steel \-ASTM A182/A82M-\ GR F6 or \-ASTM A276-\ TP410 or 416.

2.1.2.21 Shaft shall be stainless steel \-ASTM A276-\ type 410 or 416 or \-ASTM 258-\ Type 410 or 416 with renewable shaft sleeve of \-ASTM A276-\ type 316L with hard facing under mechanical seal gasket.

2.1.2.22 Testing

All shop testing shall be performed in accordance with the \-HI-01-\.

2.1.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, gpm
Pumping head, ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.1.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 1/4-inch high shall bear the equipment number as shown on the drawings.

2.1.5 Exterior Primer Coat

Exterior surfaces of the baseplate shall be primed by the manufacturer. Coating shall be applied meeting requirements of \-SSPC PA 1-\. Surface cleaning shall meet requirements of \-SSPC SP 10-\. Metal primer shall be zinc rich paint conforming to specification \-MS MIL-P-24441-\, Type 1, Class 3. Dry film thickness shall be 2 to 4 mils.

2.1.6 Exterior Topcoat

Manufacturer's standard exterior topcoat shall be applied at factory to the base plate.

2.1.7 Motors

2.1.7.1 Motor shall be furnished by the pump manufacturer and shall be suitable for the environment and operating conditions to which it will be subjected. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class I, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of "T2D - 419 degrees F" as defined by \-NFPA 70-\. The motor nameplate shall include the temperature rating of the motor and locked-rotor indicating code letters in accordance with \-NFPA 70-\, Table 430-7(b).

2.1.7.2 Voltage rating shall be 460 volts, 3 phase, 60HZ. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10% above or below rated voltage.

2.1.7.3 Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of ten (10) starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.

2.1.7.4 Motor shall be squirrel-cage induction type. Motor shall be NEMA Design B (normal-torque, low starting current).

2.1.7.5 Motor insulation shall be non-hydroscopic, NEMA Class H, 180 degrees C for motors over 10 hp and NEMA Class F, 150 degrees C for 10 hp and smaller. Stator windings shall be epoxy impregnated. The impregnations shall be applied by the vacuum and pressure process.

2.1.7.6 Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C at 3300-feet altitude) shall not exceed 80 degrees C.

2.1.7.7 Bearings shall be AFBMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

2.1.7.8 Motor enclosures shall be totally enclosed, weather sealed, fan cooled, explosion-proof and shall be listed and labeled for Class I, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections shall be terminated within a single terminal housing.

2.1.7.9 The dynamic balance, overspeed withstand capability, and sound power levels of the motor shall conform with NEMA standard requirements.

2.1.7.10 The pump manufacturer shall furnish the Contracting Officer with the recommended minimum run time for the motor.

2.1.7.11 Pump motor shall be provided with temperature limiting thermostats within the motor frame when required to meet Class I, Group D requirements.

2.1.7.12 Pump motor shall be furnished with lifting lugs on the motor casing.

2.1.7.13 Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the energy efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors,

motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies shall be (based on 1800 rpm, open drip proof):

20 hp	92.0%	75 hp	95.5%
25 hp	92.0%	100 hp	93.5%
30 hp	92.0%	125 hp	94.5%
40 hp	92.0%	150 hp	94.5%
50 hp	92.5%	200 hp	94.5%
60 hp	92.5%	600 hp	94.5%

Other motors of different speed or housing classification shall also be of the energy efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies shall have been verified in accordance with \-NEMA MG 1-\, 12.53.a., and determined using the dynamometer method as described in \-IEEE Std 112-\, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

PART 3 EXECUTION

3.1 PREPARATION FOR SHIPMENT

3.1.1 Rust Preventative

Exterior machine surfaces shall be coated with a rust preventative. Pumps shall be disassembled after the shop running tests and inspected, and internal parts shall be coated with a rust preventative before reassembling.

3.1.2 Closure of Openings

Threaded openings shall be provided with metallic plugs or caps. Flanges shall be gasketed with rubber and closed with 3/16-inch thick plate of the same outside diameter as the match flange. A minimum of four full-diameter bolts shall hold closure in place.

3.1.3 Assembly

Pumps shall be shipped assembled or a field service engineer shall be furnished to supervise the field assembly at no additional cost to the Government.

3.1.4 Bracing

Each unit shall be suitably prepared for shipment, supported and braced, with auxiliary equipment secured to prevent damage during shipment.

3.1.5 Vapor Inhibiting Wraps

Exposed shafts and shaft couplings shall be wrapped with waterproof moldable waxed cloth or vapor inhibitor paper. The seams shall be sealed with adhesive tape.

3.1.6 Shipping Identification

Each pump shall be identified with a metal tag showing the item number. Material shipped separately shall be marked with a metal tag indicating the item number for which it is intended.

3.2 INSTALLATION

Install equipment and components true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance shall be easily accessible.

3.2.1 Anchoring

Anchor equipment in place as indicated on the drawings or per manufacturer's recommendations. Check alignment of anchor bolts and/or bolt holes before installing equipment and clean-out associated sleeves. Do not cut bolts due to misalignment. Notify the Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads.

3.2.2 Grouting

Equipment which is anchored to a pad shall be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting to meet requirements of \-ASTM C827-\. Perform all grouting in accord with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.2.3 Leveling and Aligning

Level and align equipment in accord with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.2.4 Direct Drives

Alignment procedure follows.

3.2.4.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.2.4.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.2.4.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.2.4.4 Angular Alignment and End Clearance

Check angular alignment and en clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.2.4.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.002-inch tolerance, except as otherwise required by more stringent requirements of equipment manufacturer.

3.2.5 Start-up Representative

A manufacturer's field service representative shall be provided at no additional cost to the Government to check the pumps for proper operation prior to start-up and also to witness as a minimum the first two days of operation. Any additional time required due to delays or corrections by the Contractor shall be provided at no additional cost to the Government. The manufacturer's field service representative shall also instruct the required personnel in the proper operation and maintenance of the pumps.

SECTION 15880

FILTER SEPARATOR, FUELING SYSTEM

SECTION 15880

FILTER SEPARATOR, FUELING SYSTEM

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

\-API Publ 1581-\	(1989) Specifications and Qualification Procedures-Aviation Jet Fuel Filter/Separator

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME 16-\	(1992; Addenda Dec 1992, Dec 1992, Dec 1994) Boiler and Pressure Vessel Section VIII, Pressure Vessels Division 1
\-ASME B16.5-\	(1988; Errata) Pipe Flanges and Flanged Fittings
\-ASME B31.3-\	(1990; B 31.3a-1990; Errata; B 31.3b) Chemical Plant and Petroleum Refinery Piping

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM C827-\	(1987) Early Volume Change of Cementitious Mixtures

FEDERAL SPECIFICATION (FS)

\-FS FF-S-325-\	(1965; Int Amd 3) Shield, Expansion; Nail Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

MILITARY SPECIFICATIONS (MS)

\-MS MIL-C-4556-\	(Rev E) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
\-MS MIL-I-25017-\	(Rev E) Inhibitor, Corrosion/Lubricity Improver, Fuel Soluble
\-MS MIL-P-5315-\	(Rev B; NOTICE 1) Packing Preformed, Hydrocarbon Fuel Resistant

MILITARY STANDARDS

\-MIL-STD-130-\	(Rev G; NOTICE 1) Identification Marking of U.S. Military Property

\-MIL-STD-831-\ Preparation of Test Reports

1..2. SUBMITTALS.

Government approval is required for submittals with a "GA" designation; submittals having and "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES.

SD-04 Drawings\

Filter Separator\; *GA*\

Submit scaled drawings showing dimensions, tolerances, connection sizes of the vessel and accessories. Submit shop drawings for elements. Shop drawings shall include number and arrangement of elements. Shop drawings for this Section shall be submitted for Government approval. Submit technical literature on the vessel, elements, and accessories which is the manufacturer's published literature.

SD-13 Certificates\

Filter Separator\; *FIO*\

If product has been previously tested and approved by the Government, submit certification of qualification under \-API Publ 1581-\, Group II, Class B. Include description of qualification which contains element types and quantities and provide details of the configurations of vessels tested. Include name of Government Agency and date of approval.

SD-19 Operation and Maintenance Manuals\

Filter Separator\; *GA*\

Operation and maintenance information shall be submitted for equipment specified herein.

1..3. PREPRODUCTION TESTING

1..3..1. Preproduction Testing

Prior to construction of filter separators (FSR-1 THROUGH FSR-3) for the project, preproductions tests shall have been conducted in the presence of the Contracting Officer's designated Government representative [a San Antonio Air Logistics Center, Directorate of Energy Management (SA-ALC/SF) representative. The Contractor shall give the Contracting Officer 14 days notice prior to conductance of factory tests in order to schedule witnessing by representative.

1..3..1..1. Inspection and Testing

The inspection and testing of the preproduction filter separator shall be conducted on a full-scale test system in accordance with \-API Publ 1581-\ and as specified herein. The test sample shall consist of a complete filter separator with elements installed. Elements shall be representative of a

production lot. The filter separator, coalescers, and separator screens shall be identified with the manufacturer's part number.

1..3..1..2. Deviations from \-API Publ 1581-

The following are deviations to \-API Publ 1581-\ for test requirements Group II, Class B, Test Series 1, 2, and 3.

The allowable effluent fuel contamination limit for free water shall be as follows:

(a) The average free water content in a test set shall not exceed 10 parts per million and any single sample shall not exceed 15 parts per million.

(b) Additive I shall be Stadis 450 manufactured by E.I. DuPont & Nemours Co. in lieu of ASA 3.

(c) Additive II shall be DCI-4A conforming to \-MS MIL-I-25017-\ in lieu of Hitec E-515.

1..3..1..3. Data Required Prior to Tests

Submit installation data to enable Government representative to verify that the equipment has been installed and operated correctly. Submit certification from the manufacturer that the test vessel has passed a hydrostatic pressure test, and that the design conforms to \-API Publ 1581-\, Group II, Class B. Submit two sets of assembly drawings of the test vessel and accessories for approval.

1..3..1..4. Submittal of Test Documents

The test report shall be submitted to the Command Fuel Facilities Engineer or SA ALC/SF representative for Government approval. Prepare report in accordance with \-MIL-STD-831-\. In addition to results, the report shall contain complete records of the tests including data sheets, performance curves, chronological test records, photographs, sample calculations, test procedures, and a description of the test apparatus. Submit color photographs of the sample elements before and after tests. Submit one new coalescer element and one new separator element.

1..3..1..5. Required Preproduction Tests

a. Examination. A visual examination of the filter separator housing and each element shall be performed to ensure compliance with the drawings and verify workmanship requirements.

b. Hydrostatic Pressure Tests. The filter separator shall be subjected to a hydrostatic pressure of 338 pounds per square inch gage (PSIG) per requirements of the \-ASME 16-\. In addition, the inlet manifold or chamber (after installation) shall be blanked off and tested to 115 PSIG.

c. Full Scale Performance Test. The filter separator with a full set of coalescer and separator elements shall be tested to the \-API Publ 1581-\ Group II, Class B at 600 GPM in accordance with \-API Publ 1581-\ Test Method Group II, Test Series No. 2, except as otherwise specified.

d. Single Element Test. Test series 1 and 3 shall be run in an appropriate scale single element test vessel per \-API Publ 1581-\, as modified by paragraph "Deviations from API Publ 1581."

e. Coalescer Structural Test. A minimum of two coalescer elements, after being subjected to the full scale test described in paragraph entitled "Full Scale Performance Test",above, shall be subjected to a differential pressure test until rupture to determine structural strength. Each element shall be capable of withstanding a differential pressure of at least 75 PSI without rupture or bypassing of seals.

f. Disassembly Inspection. Upon completion of the tests specified above, the filter separator shall be disassembled and inspected to determine the condition of the coalescer and separator elements. Defects in the element such as swelling of the elements, or damaged gaskets shall be noted. Swelling of or damage to the elements or other parts shall be cause for rejection.

PART 2. PRODUCTS

2..1. DESIGN CONDITIONS

Design conditions shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING and as modified herein.

2..2. WORKMANSHIP

Each filter separator, including all parts and accessories, shall be free from blemishes, defects, burrs and sharp edges. The vessel shall exhibit accuracy of dimensions, accurate radii of fillets and complete marking of parts and assemblies.

2..3. CLEANING

Components of the filter separators shall be cleaned to remove dirt; excess soldering; brazing, and welding flux; welding slag; loose, spattered, or excess solder; metal chips; and other foreign materials before, during and after assembly.

2..4. WELDING

Welding shall be in accordance with \-ASME B31.3-\.

2..5. MATERIALS OF CONSTRUCTION

2..5..1. Housing

a. Carbon steel with internal epoxy coating.
b. FLOAT ASSEMBLY. Stainless steel.
c. MANUAL DRAIN VALVE. Stainless steel.
d. SIGHT GLASS. Armored clear pyrex with nickel-copper alloy ball checks.
e. DIFFERENTIAL GAUGE. Corrosion resistant piston with stainless steel valves.
f. SEPARATORS. 200 mesh stainless steel, coated on both sides with Teflon.

2..6. CONSTRUCTION

2..6..1. Housing Vessel

Each filter separator housing shall be fabricated from carbon steel and shall be internally coated with an epoxy coating in accord with \-MS MIL-C-4556-\. Coat the exterior with alkalyd resin primer (universal metal primer). Each unit shall be constructed and labeled in accordance with \-ASME 16-\. The housing shall be designed for a working pressure of 225 PSIG. Each unit shall be horizontal, end-opening type with coalescers and separators mounted side-by-side (coalescers at the bottom of the vessel and separators at the top). The head opening shall be equipped with a hinged or pivoting device to facilitate swinging the head to one side for servicing. The hinges or pivots shall support the head during servicing without distortion or misalignment. Swing-type bolts shall be used on all main closures. Unit shall be provided with 3-inch inside diameter lifting eyes spaced to support a weight of 2-1/2 times the gross weight of the filter separator. The configuration of the pressure vessel shall be as shown on the drawings. The housing shall be provided with a 3/4 inch inlet compartment fuel drain plug. A hand hole access plate shall be provided in the inlet compartment. The head shall be sealed to the body by means of an O-ring, meeting requirements of \-MS MIL-P-5315-\, mounted in a circular groove at the point of closure. Threaded base mounting adapters shall be provided for the coalescers. The separators shall be mounted on adapters with blunted Vee-type knife edges. Height of Vee section to be 0.06 inches, $\pm$ 10 percent. The filter separator vessel shall be able to withstand a force of 2,400 pounds and a moment of 2,400 foot-pounds at the flanges.

2..6..2. Legs

Four 3x3x1/4 inch angle-shaped legs shall be welded to the housing. Each leg shall be fitted with a 4x4x1/2 inch base plate drilled through with a 3/4 inch hole.

2..6..3. Inlet and Outlet Connections

The inlet and outlet connections shall be 6 inch nominal pipe size and shall be located parallel to each other as shown ont he drawings. Inlet connection shall be provided with raised face flanges, faced and drilled in compliance with \-ASME B16.5-\, Class 150. Outlet connection flange face shall match Filter Separator Control Valve (FSCV).

2..6..4. Manual Drain Valve

Each filter separator shall be equipped with a 3/4 inch stainless steel manual ball valve water and fuel drain. The valve shall be capable of draining all water, fuel and sediment from the filter separator by gravity. The valve shall be installed below the sump of the housing as shown on the drawings.

2..6..5. Sight Gauge

A 1/2 inch armored, clear pyrex liquid level gauge shall be provided for observing the water accumulation in the sump. The gauge shall be equipped with stainless steel or nickel-copper alloy ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball.

2..6..6. Differential Pressure Gauge

The housing shall be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across both coalescers and separators. The gauge shall consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. Under a differential pressure of 30 PSI, leakage past the piston shall not exceed 120 drops per minute. The cylinder shall have stainless steel and flanges with Viton O-ring seals. The high pressure inlet of the gauge shall have a 10-micron pleated paper filter and the low pressure connection shall have a fine mesh stainless steel strainer. The gauge shall have an operating pressure of 300 PSI. Differential pressure range of the gauge through approximately 3 inches of piston movement shall be 0-30 PSI with an accuracy of $\pm$ 0.5 PSI, calibrated linearly with one PSI scale graduations. High and low pressure connections shall be 1/4 inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge shall be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge shall not be damaged by up to 300 PSI differential pressure in either direction. The differential pressure gauge shall be attached to the filter separator by a gauge panel. A pressure gauge shall be attached to the differential pressure gauge to indicate the high pressure and have a range of 300 psi.

2..6..7. Automatic Air Eliminator and Pressure Relief Valves

A 3/4 inch angle pattern pressure relief valve shall be provided on top of each vessel. An automatic air eliminator shall be installed on the highest point of the vessel and shall have check valve feature. The air eliminator shall release at pressures up to 150 psi with no fuel leakage allowed.

2..6..8. Sampling Connections

Sampling connections shall be provided at the inlet and outlet connections to the housing. Each sampling connection shall consist of a 1/4 inch sampling probe where the probe faces upstream, ball valve, a quick disconnect coupling and aluminum dust cap. The sampling connections shall be capable of accepting a sampling kit for drawing the samples required to assure fuel quality.

2..6..9. Spider Assembly

Each filter separator shall contain a spider assembly to hold the coalescers and separators in position, to support them firmly against vibration. The method of stabilization shall assure an electrical bond between the spider and the vessel.

2..6..10. Coalescer and Separator Cartridges

Each filter separator shall be provided with coalescers and separators that have been qualified to the performance requirements of \-API Publ 1581-\, Group II, Class B. Coalescers shall have a minimum capacity of 2.27 gpm per inch of length, and separators shall have a minimum capacity of 8.33 gpm per inch of length.

2..6..11. Control Valve Accessories

Provide each filter separator with a control valve (FSCV), manual water drain valve, and float control valve (FC) with manual tester as specified in Section entitled "Control Valves" and shall be of the same manufacturer.

2..6..11..1. Float Control Pilot and Tester

Each housing sump shall be fitted with a float control pilot and tester specified in Section \=15101=\ CONTROL VALVES and shall be of the same manufacturer as the control valves.

2..6..12. Identification of Product

Equipment, assemblies, and parts shall be marked for identification in accordance with \-MIL-STD-130-\. The main equipment nameplate shall be mounted on the housing, and in addition to the usual \-MIL-STD-130-\ requirements, shall include the following markings in letters 3/32 inch high or larger:

Filter Separator, Liquid Fuel JP-8

Design Flow-Rate 600 gpm

Design Pressure 225 psi

Elements_____

First Stage _____ Mfg. Part No. *_____

Second Stage _____ Mfg. Part No. *_____

Contract No. *_____

Manufacturer *_____

Specification*_____

*Applicable information shall be entered by the Contractor.
*Applicable information shall be stenciled by LFM personnel.

2..6..13. Assembly

Each filter separator shall come assembled with all accessories and shall be ready for use. The functions of all components shall be tested prior to shipment and no assembly or field adjustment of valves or components shall be required.

PART 3. EXECUTION

3..1. INSTALLATION

Install equipment and components in position, true to line, level and plumb and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearance between equipment components. Equipment apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3..1..1. Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and cleanout associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition. Expansion bolt anchors provided shall be in accordance with \-FS FF-S-325-\, Group II Type 4, Class One, half-inch size.

3..1..2. Grouting

Equipment which is anchored to a pad shall be grouted in place where applicable. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding or other acceptable means. Provide necessary formwork for placing and retaining grout. Grout to be nonmetallic, nonshrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum power agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, premixed and packaged at factory with only the addition of water required at the project site. Grouting to meeting requirements of \-ASTM C827-\. Perform grouting in accord with ACI, equipment manufacturer's, and grout manufacturer's published specifications and recommendations.

3..1..3. Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolts, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shims to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3..1..4. Painting

Equipment painting shall be as specified in Section \=15060=\ MANUAL VALVES, AND FITTINGS, FUELING SYSTEM for the protective coating of aboveground pipe.

SECTION 15899

SYSTEM START-UP, FUELING SYSTEM

ATTACHMENTS: Checklist for Equipment Test

SECTION 15899

SYSTEM START-UP, FUELING SYSTEM

ATTACHMENTS: Checklist for Equipment Test

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

System Start-up Plan\; *GA*\.

The Contractor shall prepare a detailed written plan for implementation of system start-up. The plan shall be submitted for Government approval 30 days prior to system start-up. The plan shall include a list of personnel by trade, list of key personnel, safety equipment, list of miscellaneous equipment such as two-way radios personnel transportation vehicles etc. and detailed procedures and schedules. The Contractor shall be responsible for implementing system start-up in coordination with ongoing base operations.

Certification of Entire System\; *FIO*\.

Prior to the acceptance of the newly constructed system after Phase III and after Phase IV by the Government, all installed mechanical and electrical equipment shall be inspected and approved by the Contracting Officer. The Contractor shall give the Contracting Officer 14 days notice in order to schedule the Command Fuel Facilities Engineer and the Command Fuels Management Officer (who will act only as a technical consultants to the Contracting Officer and shall not have any contract authority) for participation in the inspection and equipment tests and final acceptance procedures and approval. Any deficiencies observed shall be corrected by the Contractor without cost to the Government.

SD-09 Reports\

Test Reports\; *FIO*\.

Submit written test reports to the Contracting Officer prior to the final acceptance procedure. Information reported shall include:

a. Elapsed operating time.
b. Tank liquid level readings.
c. System flow rate.
d. System pressure gage readings.
e. Number identification of pumps running.
f. Pump RPM, amperage, and voltage.
g. Condition of fuel samples.
h. Control valve performance (including flow rate and pressure) during emergency shutoff, downstream valve closure, and relief operation.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Temporary flushing lines and equipment shall be equal in strength, stability, and materials to the associated permanent components. However, spools may be carbon steel. Additional design conditions shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING.

2.2 SOURCES OF MATERIAL AND EQUIPMENT

2.2.1 Material and Equipment

The Contractor shall provide material, equipment and labor not specified to be Government-furnished and required for proper start-up of the system. Equipment shall include but not be limited to the following:

a. Temporary strainers.
b. Pipe spools.
c. Flow meters.
d. Pressure gages.
f. The Contractor must have on hand sufficient filter elements and coalescer cartridges to adequately clean the system. During cleaning operation, Contractor shall provide a flow versus pressure drop graph for each filter separator. Graph format shall be as shown at end of this Section. Contractor shall change coalescers and cartridges upon reaching a differential pressure of 15 psi or when pressure drop is less than previous graph or fails to increase properly. Isolate each filter separator, one at a time and use one fueling pump to obtain rated flow rate (600 GPM). A minimum of one complete set of elements and coalescers for each filter separator shall be turned over to the Government after new coalescers and cartridges are installed in each filter separator vessel after completion of acceptance testing.

2.2.2 Government-Furnished Material and Equipment

The Government will furnish the following materials, equipment and services during the performance of the work under this section.

2.2.2.1 Aircraft Turbine Fuel

The Government will provide the fuel necessary for system testing. The Contractor shall notify the Contracting Officer one hundred and twenty (120) days in advance of the requirements. Additional fuel will be provided by the Government as required for satisfactory flushing of the system. Upon satisfactory completion of the flushing and cleaning operations, the Government will supply the additional quantities of fuel required to complete the other work under this section. Fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, the cleaning and coating of the interior surfaces of the operating storage tanks and the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, filter separators and other such equipment. Fuel delivered to the system shall remain the property of the Government and the Contractor shall reimburse the Government for shortages not attributable to normal handling losses. The Government shall be reimbursed for fuel lost as a result of defective materials or workmanship. An empty

Operating Tank shall never be filled at a rate greater than 3-feet per second until fill nozzle is completely submerged and the tank's internal floating pan is floating.

2.2.2.2 Tank Trucks

Commercial tank cars and operation of same will be furnished by the Government.

2.2.2.3 Utilities

Electric power required for the performance of the work under this section will be furnished at no charge to the Contractor.

PART 3 EXECUTION

3.1 PREPARATIONS FOR FLUSHING

Upon completion of the system to the satisfaction of the Contracting Officer and the Command Fuel Facilities Engineer, the Contractor shall make the following preparations for flushing the system.

3.1.1 Protection of Equipment

The following items shall be removed from the system prior to start of flushing operations and, where applicable, replaced with spools of pipe, diameter equal to the item removed.

a. Control valves.
b. Sensors which are exposed to the fluid.
c. Coalescer and separator elements in filter separators.

After flushing, the above items shall be reinstalled in the system and the spool sections turned over to the Contracting Officer.

3.1.2 Strainers

Temporary 40 mesh cone type strainers shall be installed in the suction line ahead of each fueling pump for first pass only. Any damaged strainers shall be replaced by the Contractor at no additional cost to the Government.

3.2 FLUSHING

Flushing procedures shall precede cleaning procedures. The offload line, pump house piping, supply and return lines to the operating tanks, and product recovery lines shall be flushed with fuel until the fuel being delivered is free of construction debris to the satisfaction of the Contracting Officer. Samples of fuel shall be taken and tested by the designated government agency and shall be free of gross contamination, maximum of 8.0 mg/gallon solids and free water not to exceed 2 ml per quart.

3.2.1 System Piping

The flushing of system pipelines shall be accomplished by pumping fuel from one of the operating tanks through the fueling system piping and back to another tank. Air shall be bled from system high points. The procedure shall

be continued until the fuel being delivered into the tanks is acceptable to the Contracting Officer. After the system has been flushed to the satisfaction of the Contracting Officer, the Contractor shall remove any water remaining in the low point drains and remove any accumulated water from Operating Tank sumps and bottoms by means of the Water Draw-off systems. Cone strainers shall be kept clean in order to insure maximum flow rate. Upon completion of the first flushing operations, the cone strainers shall be removed from the system. In addition, baskets from all strainers shall be removed and cleaned.

3.2.1.1 Offload Line

Flushing of the lines shall occur during the filling operations. Samples of the incoming fuel shall be taken at the point of connection with supply to the filler separator. These samples shall be taken at one hour intervals and shall be tested by the designated government agency.

3.2.1.2 Pump House Piping

Remove equipment as specified in paragraph Protection of Equipment. Perform the following flushing operations by withdrawing fuel from one operating tank and returning it to another tank. Circulate a sufficient amount of fuel for each operation. Bleed air from high points.

a. Position manual valves to circulate fuel through filter separators.

b. Position manual valves to circulate fuel to the apron. Flush each line using two fueling pumps.

3.2.1.3 Product Recovery Tank Lines

During the flushing operate all manual drain lines individually to flush their connection to the product recovery tank. Fill the tank a minimum three times.

3.3 CLEANING

After initial flushing is completed, piping shall be cleaned in accordance with the procedure specified hereafter.

3.3.1 Preparation for Cleaning

Filter elements shall be installed in the filter separators. Adjust filter separator flow control valve. Valves and equipment removed for flushing shall be reinstalled. Cone strainers shall be removed. Transfer the contents from one operating tank to the other for the purposes of cleaning.

3.3.2 Cleaning Requirements

Cleaning shall continue until Contracting Officer certifies that the fuel passes the color and particle assessment method as defined in T.O. 42B-1-1 or contains 2 milligrams per gallon or less of particulate. Fuel shall also contain 10 parts per million or less of free water. Sampling and testing shall be done by the Air Force .

3.3.3 Cleaning Procedure

During cleaning procedure periodically bleed air through high point vent and drain water through low point drains.

3.3.3.1 Offload Line

Continue to receive fuel and circulate it until fuel samples taken at the tanks meet the requirements of paragraph 3.3.2.

3.3.3.2 Pump House Piping

Pump house piping shall be cleaned as follows:

a. Position manual valves so that fuel is withdrawn from one operating tank, circulated through the system, then returned to the operating tank through the receiving filter separators.

b. Clean the piping system using two pumps (if available) at a time. Alternate the fueling pumps (if available) during the operation to clean the individual fueling pump suction and discharge lines.

e. Monitor pressure drop through the filter separators during each cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

f. Periodically take samples from all sample connections. Cleaning shall continue until the fuel meets the specified requirements.

3.3.3.3 Product Recovery Lines

Repeat the process described under initial flushing until samples taken meet the requirements.

3.4 CONTROL VALVE ADJUSTMENT

The filter separator control valves and transfer pump air block/check valve shall be checked and adjusted as follows:

3.4.1 Rate of Flow Control Feature on Transfer Pump Air Block/Check Valve

3.4.1.1 Run one pump at a time and adjust rate of flow features (640 gpm), 300 gpm and 150 gpm.

3.4.2 Control Valves on Issue Filter Separator Downstream Side

3.4.2.1 Position valves so that one fueling pump can pump through only one filter separator..

3.4.2.2 Start the pump and adjust the filter separator control valve for the rated flow capacity of the filter separator (600 gpm).

3.4.2.3 Repeat above for each remaining filter separator.

3.5 EQUIPMENT TESTS

After completion of flushing, cleaning, and control valve and electrical components adjusting operations, the tests specified hereinafter shall be

performed. After cleaning is complete and prior to performance testing, field adjustment of automatic control valves and pump controls while in operation shall be made only by the valve manufacturer's authorized field test engineer. For final adjustment of installed electrical control equipment the Contractor shall provide an experienced electrical engineer, factory representative of CP manufacturer. Tests will be witnessed by the Contracting Officer, the Command Fuel Facilities Engineer and the Command Fuel Management Officer. . Contractor shall complete and submit to Contracting Officer the "CHECK LIST FOR EQUIPMENT TEST" provided hereinafter.

3.5.1 Fuel Receiving

Fuel will be received by railcars at the offload connections.

3.5.2 Fuel Delivery

Deliver fuel to the tank and then to the apron.

NOTE: SELECT ARRANGEMENTS FOR PANTOGRAPHS OR HYDRANT HOSE TRUCKS.

3.5.3 Pump Operation

Operation to start and stop the pumps shall be demonstrated by the Contractor in the presence of the Contracting Officer. The operating sequence shall be repeated with each of the pumps. For this test, the flow rates shall be measured. Flow rates and test results shall be recorded and witnessed by the Contractor.

3.5.4 Emergency Shutdown

With one pump circulating fuel through the system, test each "Emergency Stop" pushbutton station to verify that the pump stops. Repeat above procedure for each pump and "Emergency Stop" pushbutton station.

3.5.5 Filter Separator Float Control Valves with Manual Tester

Using the manual float control test level on each Filter Separator, lift the weight from the float ball slowly and observe the following:

Operation and closure of the water slug shut-off feature on the Filter Separator Control Valve.

3.6 PERFORMANCE TESTING

Testing as performed under the above paragraphs shall be considered to be part of the performance testing after the Contractor has made the required adjustments to the various equipment and controls and demonstrates to the satisfaction of the Contracting Officer and the Command Fuel Facilities Engineer , that these portions of the systems are working as specified. The Contractor shall notify the Contracting Officer 15 days in advance of the test to permit arrangement for the use of Government-furnished items.

3.6.1 Final Performance Test

The final performance test shall consist of performance of the system during actual offloading.

3.6.1.1 Satisfactory Performance

In the event a portion of the system or any piece of equipment fails to meet the test, the Contractor shall make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. The determination of satisfactory performance shall be made by the Contracting Officer and the Command Fuel Facilities Engineer .

3.6.2 Final Acceptance

The system shall be filled with fuel and shall be operable and leak-free prior to acceptance. Anything wet with fuel is considered to be leaking.

ITEM 7 - FILTER SEPARATOR FLOAT CONTROL VALVE MANUAL TEST:

FILTER SEPARATOR NO.	WATER SLUG FEATURE ON FILTER SEPARATOR CONTROL VALVE FUNCTIONED	
	YES	NO

DATE: _____

TIME: _____

TEMPERATURE: _____ F

TEST CONDUCTED BY: _____

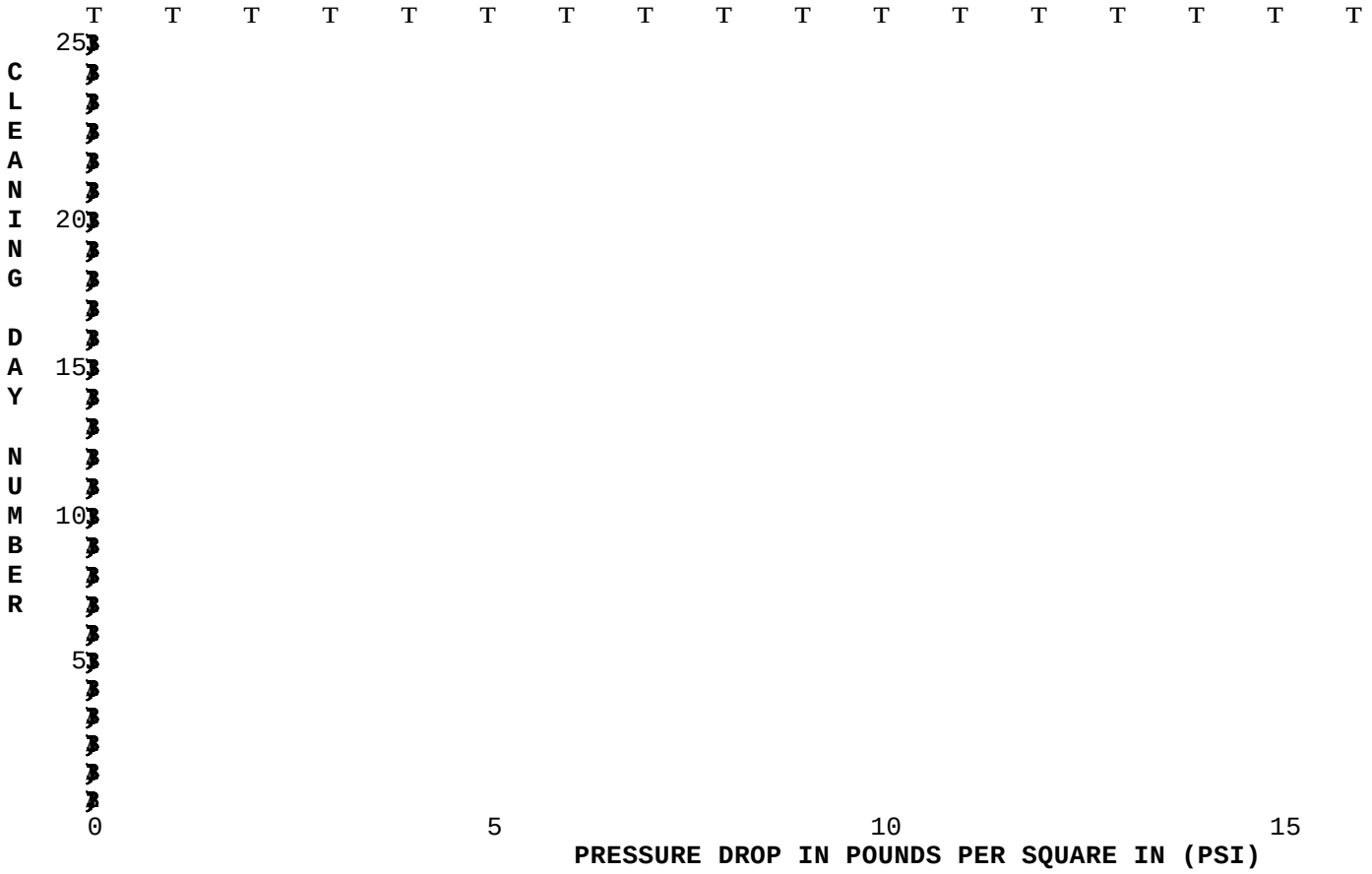
```
)
*I Certify that the values recorded are accurate and correct:            *
*                                                                        *
*DATE:   _____________________________________________                   *
*                                                                        *
*SIGNATURE:  _________________________________________                   *
*                                                                        *
*ORGANIZATION:  ______________________________________                   *
*                                                                        *
)

)
*I witnessed all tests required to produce values recorded.              *
*                                                                        *
*DATE:    ____________________________________________                   *
*                                                                        *
*SIGNATURE:  _________________________________________                   *
*                                                                        *
*ORGANIZATION:  ______________________________________                   *
*                                                                        *
)
```

PERSONNEL PRESENT DURING EQUIPMENT TEST:

NAME	ORGANIZATION	COMMERCIAL PHONE #
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )

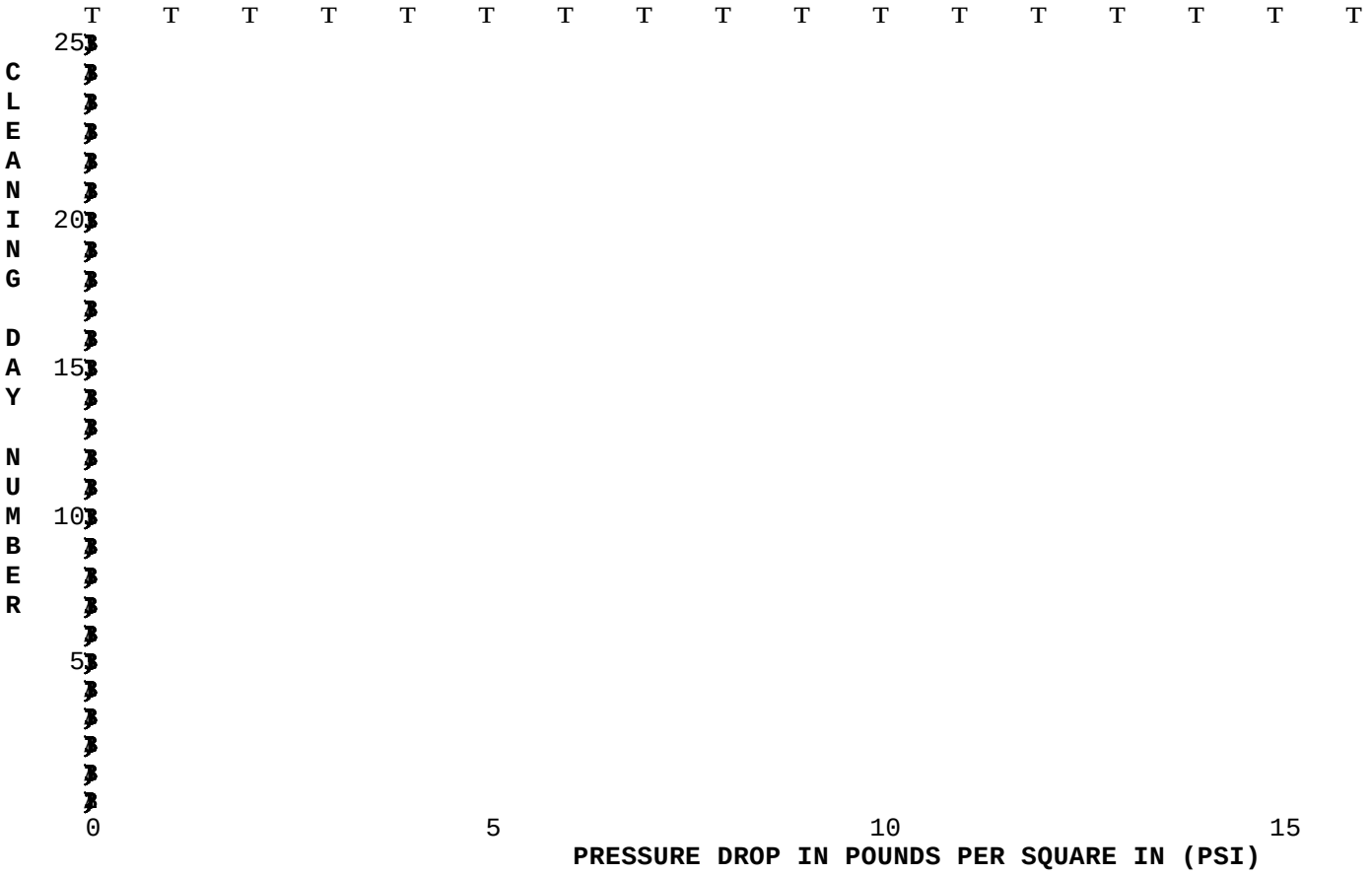
REMARKS:



CLEANING OPERATION DAILY FLOW VS. PRESSURE DROP GRAPH FOR FILTER SEPARATOR NO.

***ELEMENT CHANGE CRITERIA:** **1) When pressure drop across filter separator reaches 15 PSI**
2) When pressure drop is less than previous plot or fails to

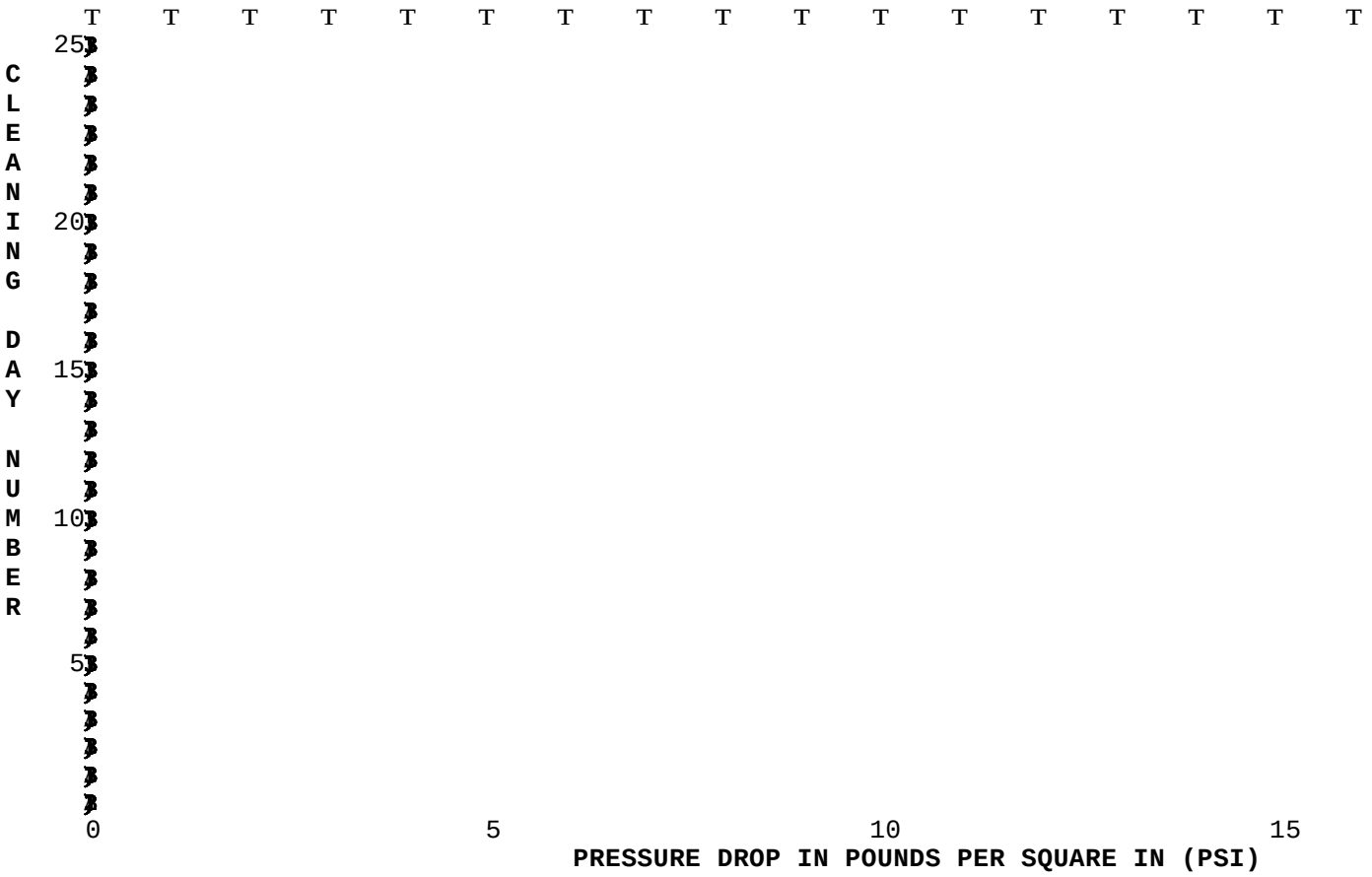
STARTING DATE: _____ **SIGNATURE:** _____



CLEANING OPERATION DAILY FLOW VS. PRESSURE DROP GRAPH FOR FILTER SEPARATOR NO.

***ELEMENT CHANGE CRITERIA:** **1) When pressure drop across filter separator reaches 15 PSI**
2) When pressure drop is less than previous plot or fails to

STARTING DATE: _____ **SIGNATURE:** _____



CLEANING OPERATION DAILY FLOW VS. PRESSURE DROP GRAPH FOR FILTER SEPARATOR NO.

***ELEMENT CHANGE CRITERIA:** **1) When pressure drop across filter separator reaches 15 PSI**
2) When pressure drop is less than previous plot or fails to

STARTING DATE: _____ **SIGNATURE:** _____

SECTION 16370

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

SECTION 16370

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C29.1-\	(1988) Electrical Power Insulators - Test Methods
\-ANSI C29.2-\	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
\-ANSI C29.5-\	(1984; R 1991) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
\-ANSI C29.6-\	(1984) Wet-Process Porcelain Insulators - High-Voltage Pin Type
\-ANSI C29.8-\	(1985) Wet-Process Porcelain Insulators - Apparatus, Cap and Pin Type
\-ANSI C29.9-\	(1983) Wet-Process Porcelain Insulators - Apparatus, Post-Type
\-ANSI C135.1-\	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
\-ANSI C135.2-\	(1987) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
\-ANSI C135.4-\	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
\-ANSI C135.14-\	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
\-ANSI C135.17-\	(1988) Insulator Pins with Lead Threads for Overhead Line Construction Galvanized Ferrous Bolt-Type
\-ANSI C135.22-\	(1988) Galvanized Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
\-ANSI C135.33-\	(1988) Crossarm Gains, Galvanized Ferrous

\-ANSI O5.1-\	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 123-\	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
\-ASTM A 153-\	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
\-ASTM A 575-\	(1989) Steel Bars, Carbon, Merchant Quality, M-Grades
\-ASTM A 576-\	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality
\-ASTM B 1-\	(1990) Hard-Drawn Copper Wire
\-ASTM B 8-\	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
\-ASTM B 117-\	(1994) Operating Salt Spray (Fog) Testing Apparatus
\-ASTM D 1654-\	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environment

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

\-AWPA C4-\	(1995) Poles - Preservative Treatment by Pressure Processes
\-AWPA C25-\	(1995) Sawn Crossarms - Preservative Treatment by Pressure Processes
\-AWPA P1/P13-\	(1995) Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)
\-AWPA P5-\	(1995) Standards for Waterborne Preservatives
\-AWPA P8-\	(1995) Standards for Oil-Borne Preservatives
\-AWPA P9-\	(1992) Standards for Solvents and Formulations for Organic Preservative Systems

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

\-IEEE C2-\	(1997) National Electrical Safety Code
\-IEEE C37.41-\	(1994) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
\-IEEE C37.60-\	(1981; R 1992) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic

	Circuit Reclosers and Fault Interrupters for ac Systems
\&\-IEEE C37.63-\	(1984; R 1990) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems&\
\-IEEE C57.12.00-\	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
\-IEEE C57.19.00-\	(1991) IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
\-IEEE C57.19.01-\	(1991) IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
\-IEEE C62.1-\	(1989; R 1994) Surge Arresters for ac Power Circuits
\-IEEE C62.2-\	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
\-IEEE C62.11-\	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
\-IEEE Std 81-\	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
\-IEEE Std 100-\	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA HV 2-\	(1984; R 1991) Application Guide for Ceramic Suspension Insulators
\-NEMA LA 1-\	(1992) Surge Arresters
\-NEMA SG 2-\	(1993) High Voltage Fuses

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code

RURAL ELECTRIFICATION ADMINISTRATION (REA)

\-REA Bulletin 1728H-701-\	(1993) REA Specification for Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys

UNDERWRITERS LABORATORIES (UL)

\-UL 467-\ (1993; Rev thru Aug 1996) Grounding and Bonding Equipment

1..2. GENERAL REQUIREMENTS

1..2..1. Terminology

Terminology used in this specification is as defined in \-IEEE Std 100-\.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Manufacturer's Catalog\; *GA*\.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists\; *GA*\.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

Installation Procedures\; *GA*\.

As a minimum, installation procedures for regulators, transformers and reclosers. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-04 Drawings\

Electrical Distribution System\; *GA*\.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

a. Poles.

b. Crossarms.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component

parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.

As-Built Drawings\; *FIO*\.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-09 Reports\

Factory Test\; *GA*\.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

Field Testing\; *FIO*\.

A proposed field test plan 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Test Reports\; *GA*\.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings, and including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

SD-13 Certificates\

Materials and Equipment\; *GA*\.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies.

SD-19 OPERATION AND MAINTENANCE MANUALS\

Electrical Distribution System\; *GA*\.

Six copies of Operation and Maintenance manuals electrical distribution system shall be provided, within 7 calendar days following the completion of tests and shall include assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets shall be provided for each section of the

manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

Three additional copies of the instructions manual within 30 calendar days following the approval of the manuals.

1..4. DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Wood poles held in storage for more than 2 weeks shall be stored in accordance with \-ANSI O5.1-\. Handling of wood poles shall be in accordance with \-ANSI O5.1-\, except that pointed tools capable of producing indentations more than inch in depth shall not be used.

1..5. EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2. PRODUCTS

2..1. GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..2. STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2..3. NAMEPLATES

2..3..1. General

Each major component shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid-dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal.

2..4. CORROSION PROTECTION

2..4..1. Aluminum Materials

Aluminum shall not be used.

2..4..2. Ferrous Metal Materials

2..4..2..1. Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with \-ASTM A 153-\ and \-ASTM A 123-\.

2..4..2..2. Equipment

Equipment and component items, including but not limited to transformers and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in \-ASTM B 117-\ without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with \-ASTM D 1654-\ with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2..4..3. Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section \=09900=\ PAINTING, GENERAL.

2..5. CONDUCTORS, CONNECTORS, AND SPLICES

2..5..1. NOT USED

2..5..2. Copper Conductors

Hard-drawn-copper conductors shall comply with \-ASTM B 1-\ and \-ASTM B 8-\ as appropriate for the conductor size.

2..5..3. Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors.

2..6. MEDIUM-VOLTAGE LINES

2..6..1. Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall be hard-drawn-copper, CU. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

2..7. NOT USED

2..8. POLES AND HARDWARE

Poles shall be of lengths and classes indicated.

2..8..1. Wood Poles

Wood poles shall comply with \-ANSI O5.1-\, and shall be pressure treated in accordance with \-AWPA C4-\, with creosote conforming to \-AWPA P1/P13-\ or with oil-borne preservatives and petroleum conforming to \-AWPA P8-\ and \-AWPA P9-\, respectively, and waterborne preservatives conforming to \-AWPA P5-\. Waterborne preservatives shall be either chromated or ammoniacal copper arsenate. Any species listed in \-ANSI O5.1-\ for which a preservative treatment is not specified in \-AWPA C4-\, shall not be used; northern white cedar, if treated as specified for western red cedar, and western fir, if treated as specified for Douglas fir, may be used. Wood poles shall have pole markings located approximately 10 feet from pole butts for poles 50 feet or less in length, and 14 feet from the pole butts for poles longer than 55 feet in length. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, gained, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

2..8..2. NOT USED

2..8..3. NOT USED

2..8..4. Pole Line Hardware

Zinc-coated hardware shall comply with \-ANSI C135.1-\, \-ANSI C135.2-\, \-ANSI C135.4-\, \-ANSI C135.14-\, \-ANSI C135.17-\, \-ANSI C135.22-\, and \-ANSI C135.33-\. Steel hardware shall comply with \-ASTM A 575-\ and \-ASTM A 576-\. Hardware shall be hot-dip galvanized in accordance with \-ASTM A 153-\. Pole-line hardware shall be hot-dip galvanized steel. . Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

2..9. INSULATORS

Insulators shall comply with \-NEMA HV 2-\ for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

2..9..1. Medium-Voltage Line Insulators

Medium-voltage line insulators shall comply with \-ANSI C29.2-\, \-ANSI C29.5-\, and \-ANSI C29.6-\, as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation.

Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.

TABLE I

MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
Up to 5 kV	57-1 or 11	55-3	One 52-1
	57-1 or 11	55-5	Two 52-1
6 kV to 15 kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4

2..9..2. NOT USED

2..9..3. NOT USED

2..9..4. Apparatus Insulators

Apparatus insulators shall comply with \-IEEE C57.19.00-\, \-IEEE C57.19.01-\, \-ANSI C29.8-\, and \-ANSI C29.9-\ as applicable.

2..10. CROSSARM ASSEMBLIES

2..10..1. Crossarms

Crossarms shall comply with \-REA Bulletin 1728H-701-\ and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to \-AWPA C25-\, and a 1/4 inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-l/4 inches in depth in accordance with \-IEEE C2-\ for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

2..10..2. Crossarm Gains

Crossarm gains shall comply with \-ANSI C135.33-\.

2..11. NOT USED

2..12. NOT USED

2..13. FUSES AND SWITCHES, MEDIUM-VOLTAGE

2..13..1. Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with \-NEMA SG 2-\ and shall be of the loadbreak open type construction rated 15 kV and of the extra-heavy -duty type . Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

2..14. NOT USED

2..15. NOT USED

2..16. SURGE ARRESTERS

Surge arresters shall comply with \-NEMA LA 1-\ and \-IEEE C62.1-\, \-IEEE C62.2-\, and \-IEEE C62.11-\, and shall be provided for protection of aerial-to-underground transitions and other indicated equipment. Arresters shall be intermediate class, rated as shown. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type suitable for outdoor installations.

2..17. NOT USED

2..18. GROUNDING AND BONDING

2..18..1. Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2..18..2. Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be \-ASTM B 8-\ soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2..19. NOT USED

2..20. WARNING SIGNS

Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with \-IEEE C2-\.

2..21. NOT USED

2..22. FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing.

a. High-Voltage Fuses: Manufacturer's standard tests in accordance with \-IEEE C37.41-\.

b. Electric Power Insulators: Manufacturer's standard tests in accordance with \-ANSI C29.1-\.

PART 3. EXECUTION

3..1. GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3..1..1. Conformance to Codes

The installation shall comply with the requirements and recommendations of \-IEEE C2-\ for heavy loading districts, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of \-NFPA 70-\.

3..1..2. Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

3..2. POLE INSTALLATION

Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be wood poles utilizing crossarm construction. Crossarm construction shall be provided for support of other equipment, except where direct-pole mounting is indicated. Provision for communication services is required on pole-line construction, except where specifically noted otherwise. A vertical pole space of not less than 2 feet shall be reserved at all locations.

3..2..1. Wood Pole Setting

Wood Pole Setting: Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. In rocky or swampy ground, pole-setting depths shall be decreased or increased respectively in accordance with the local utility's published standards and as approved. In swampy or soft ground, a bog shoe shall be used where support for a pole is required. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be

kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations, and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into the hole in 6 inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around each pole in a conical shape and packed tightly to drain water away from poles.

TABLE II

MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5.0	5.0
25	5.5	5.5
30	5.5	5.5
35	6.0	6.0
40	6.5	6.5
45	6.5	7.0
50	7.0	7.5
55	7.5	8.0
60	8.0	8.5
65	8.5	9.0
70	9.0	9.5

3..3. CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3..3..1. Line Arms and Buck Arms

Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buckarms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

3..3..2. Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

3..4. NOT USED

3..5. CONDUCTOR INSTALLATION

3..5..1. Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

3..5..2. Connectors and Splices

Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors.

3..5..3. Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in TABLE II.

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any size	6 or 4

3..6. NOT USED

3..7. CONNECTIONS TO UTILITY LINES

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the utility electric lines.

3..8. CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to poles by conduit supports two-hole galvanized steel pipe straps spaced not more than 10 feet apart and with one support not more than 12 inches from any bend or termination. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the riser conduit or guard. Cables guards shall be secured in accordance with the manufacturers published procedure. Risers shall be equipped with bushings to protect cables. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable.

3..9. NOT USED

3..10. GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaires, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, panel enclosures, transformers, capacitors, recloser frames (cases) and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where indicated.

3..10..1. Grounding Electrodes

Grounding electrodes shall be installed as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.

b. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors , to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of 10 feet apart, . In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notifies immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use \-UL 467-\ approved connectors.

3..10..2. Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with \-UL 467-\, and those below grade shall be made by a fusion-welding process.

3..10..3. Grounding Electrode Conductors

On multi-grounded circuits, as defined in \-IEEE C2-\, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. For single grounded or ungrounded systems, provide a grounding conductor for the surge arrester and equipment grounding conductors and a separate grounding conductor for the secondary neutrals. Grounding electrode conductors shall be sized as shown. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor, as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3..11. *FIELD TESTING*

3..11..1. General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

3..11..2. Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3..11..3. \+Ground-Resistance Tests+

The resistance of each pole ground shall be measured using the fall-of-potential method defined in \-IEEE Std 81-\. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

3..11..4. NOT USED

3..11..5. NOT USED

3..11..6. NOT USED

3..11..7. NOT USED

3..11..8. \+Pre-Energization Services+

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer.

3..11..9. \+Operating Tests+

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3..12. NOT USED

3..13. ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C37.46-\	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
\-ANSI C57.12.26-\	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
\-ANSI C57.12.28-\	(1988) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity
\-ANSI C80.1-\	(1990) Rigid Steel Conduit - Zinc Coated
\-ANSI C119.1-\	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
\-ANSI C135.30-\	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 123-\	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
\-ASTM A 153-\	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
\-ASTM B 8-\	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
\-ASTM B 117-\	(1994) Operating Salt Spray (Fog) Testing Apparatus
\-ASTM D 923-\	(1991) Sampling Electrical Insulating Liquids
\-ASTM D 1654-\	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
\-ASTM D 4059-\	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

\-ASTM F 883-\	(1990) Padlocks

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C2-\	(1997) National Electrical Safety Code
\-IEEE C57.12.00-\	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
\-IEEE C57.98-\	(1993) Guide for Transformer Impulse Tests
\-IEEE C62.1-\	(1989; R 1994) Surge Arresters for ac Power Circuits
\-IEEE C62.2-\	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
\-IEEE C62.11-\	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
\-IEEE Std 48-\	(1996) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
\-IEEE Std 81-\	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
\-IEEE Std 100-\	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms
\-IEEE Std 386-\	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
\-IEEE Std 404-\	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 46 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
\-IEEE Std 592-\	(1990) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA FB 1-\	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
\-NEMA FU 1-\	(1986) Low Voltage Cartridge Fuses
\-NEMA LA 1-\	(1992) Surge Arresters
\-NEMA SG 2-\	(1993) High Voltage Fuses

\-NEMA TC 5-\	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct
\-NEMA TC 6-\	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
\-NEMA TC 7-\	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
\-NEMA WC 7-\	(1993) Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
\-NEMA WC 8-\	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

\-UL 6-\	(1993; Rev March 96) Rigid Metal Conduit
\-UL 198C-\	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types
\-UL 198D-\	(1995) Class K Fuses
\-UL 198E-\	(1988; Rev Jul 1988) Class R Fuses
\-UL 198H-\	(1988; Rev thru Nov 1993) Class T Fuses
\-UL 467-\	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
\-UL 486A-\	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
\-UL 514A-\	(1996) Metallic Outlet Boxes
\-UL 651-\	(1995) Schedule 40 and 80 Rigid PVC Conduit
\-UL 1242-\	(1996) Intermediate Metal Conduit

1..2. GENERAL REQUIREMENTS

1..2..1. Terminology

Terminology used in this specification is as defined in \-IEEE Std 100-\.

1..3. SUBMITTALS

Governmental approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Manufacturer's Catalog Data\; *GA*\.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists\; *GA*\.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Procedures\; *GA*\.

As a minimum, installation procedures for transformers, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-04 Drawings\

Electrical Distribution System\; *GA*\.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following: Transformer

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

As-Built Drawings\; *FIO*\.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-09 Reports\

Factory Test\; *GA*\.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing\; *GA*\.

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Test Reports\; *GA*\.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Cable Installation Reports\; *GA*\.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-13 Certificates\

Materials and Equipment\; *GA*\.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Splicer Qualification\; *GA*\.

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications\; *GA*\.

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

SD-19 OPERATION AND MAINTENANCE MANUALS\

Electrical Distribution System\; *GA*\.

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

1..4. DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers shall be stored in accordance with the manufacturer's requirements.

1..5. EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2. PRODUCTS

2..1. STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..2. NAMEPLATES

2..2..1. General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

2..2..2. Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with \-IEEE C57.12.00-\. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 2 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 2 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2..3. CORROSION PROTECTION

2..3..1. Aluminum Materials

Aluminum shall not be used.

2..3..2. Ferrous Metal Materials

2..3..2..1. Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with \-ASTM A 153-\ and \-ASTM A 123-\.

2..3..2..2. Equipment

Equipment and component items, including but not limited to pad-mounted transformer, transfer switch, and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in \-ASTM B 117-\ without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with \-ASTM D 1654-\ with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2..3..3. Finishing

The exterior of pad-mounted transformers and transfer switch shall be factory primed and painted brown (Federal Specification number 20059 or Sherman William's number 1049), minimum of three mil's thick. Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section \=09900=\ PAINTING, GENERAL.

2..4. CABLES

Cables shall be single conductor type unless otherwise indicated.

2..4..1. Conductor Material

Underground cables shall be of soft drawn copper conductor material.

2..4..2. Medium-Voltage Cables

2..4..2..1. General

Medium voltage cables shall conform to the requirements of \-NEMA WC 8-\ for cables utilizing ethylene-propylene-rubber (EPR) insulation. Cables shall be in accordance with the requirements of \-NFPA 70-\.

2..4..2..2. Insulation

Cables shall utilize ethylene-propylene-rubber (EPR) insulation. Cables shall be provided with 133 percent insulation level.

2..4..2..3. Jackets

Cables shall be provided with a nonmetallic jacket.

2..4..2..4. Neutrals

Neutral conductors of grounded neutral systems shall be of the same insulation material as phase conductors, except that a 600-volt insulation rating is acceptable.

2..4..2..5. Shielding

Cables rated for above 2 kV shall have both conductor and insulation shielding for each phase

2..4..2..6. Ratings

Medium-voltage cables shall be rated for a circuit voltage 15 kV.

2..4..3. Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of \-NFPA 70-\. Cables shall utilize cross-linked thermosetting polyethylene (XLP) insulation and shall conform to the requirements of \-NEMA WC 7-\ or ethylene-propylene-rubber (EPR) insulation and shall conform to the requirements of \-NEMA WC 8-\.

2..4..3..1. NOT USED

2..4..3..2. In Duct

Cables shall be single-conductor cable, Type RHW, THW, THWN, TW, USE, or XHHW in accordance with \-NFPA 70-\. Cables in factory-installed, coilable-plastic-duct assemblies shall conform to \-NEMA TC 5-\ or \-NEMA TC 7-\.

2..5. CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2..5..1. Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with \-IEEE Std 404-\ and \-IEEE Std 592-\. Medium-voltage cable terminations shall comply with \-IEEE Std 48-\. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

2..5..2. Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with \-IEEE Std 386-\ and \-IEEE Std 592-\ and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

2..5..3. Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an

insulated, solderless, pressure type connector, conforming to the applicable requirements of \-UL 486A-\. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of \-UL 486A-\. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to \-ANSI C119.1-\ or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2..5..4. Terminations

Terminations shall be in accordance with \-IEEE Std 48-\, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2..5..4..1. Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of \-IEEE Std 48-\ for the next higher Basic Insulation Level (BIL) level. Anti-tracking tape shall be applied over exposed insulation of preformed molded elastomer terminations.

2..5..4..2. Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 25 inches long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2..6. CONDUIT AND DUCTS

Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage lines. Low-voltage lines that are in 1 1/2" conduit or larger shall be concrete encased. Other low voltage lines may be direct-burial, thick-wall type. Where concrete encasement is not required, low-voltage circuits may utilize factory-installed cable in coilable plastic duct.

2..6..1. Metallic Conduit

Intermediate metal conduit shall comply with \-UL 1242-\. Rigid galvanized steel conduit shall comply with \-UL 6-\ and \-ANSI C80.1-\. Metallic conduit fittings and outlets shall comply with \-UL 514A-\ and \-NEMA FB 1-\.

2..6..2. Nonmetallic Ducts

2..6..2..1. NOT USED

2..6..2..2. Concrete Encased Ducts

\-UL 651-\ Schedule 40 or \-NEMA TC 6-\ Type EB.

2..6..2..3. Direct Burial

\-UL 651-\ Schedule 80 , or \-NEMA TC 6-\ Type DB.

2..6..3. Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2..7. HANDHOLES

Handholes shall be as indicated. Strength of handholes and their frames and covers shall conform to the requirements of \-IEEE C2-\. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Handhole covers in sidewalks, and turfed areas shall be of the same material as the box.

2..8. POLES AND HARDWARE

Poles and hardware shall be in accordance with Section \=16370=\ ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

2..9. TRANSFORMERS

Transformers shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV between phases for 133 percent insulation level.

2..9..1. NOT USED

2..9..2. Pad-Mounted Transformers

Pad-mounted transformers shall comply with \-ANSI C57.12.26-\ and shall be of the loop feed type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped

as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of \-ANSI C57.12.26-\. Pentahead locking bolts shall be provided with provisions for a padlock.

2..9..2..1. High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, drawout, dry-well-mounted, current-limiting fuses , medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on a second set of high voltage bushings.

2..9..2..2. Load-Break Switch

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment. Operation of switches shall be as follows:

ARRANGEMENT #	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION LINE A SW OPEN	LINE A SW CLOSE	LINE B SW OPEN	LINE B SW CLOSE	XFMR SW OPEN	XFMR SW CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and		X		X	X	

	loop closed			
5	Transformer open and loop open	X	X	X

2..9..2..3. Transformer Tank Sections

Transformers shall comply with \-IEEE C57.12.00-\, and \-ANSI C57.12.26-\ and shall be of the mineral oil-insulated type . Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity .....500 kVA.

Impedance .....5%.

Temperature Rise .....65 degrees C.

High-voltage winding .....12470 volts.

High-voltage winding connections .....wye.

Low-voltage winding .....480/277 volts.

Low-voltage winding connections ..... wye.

2..9..2..4. Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

2..9..2..5. Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with \-IEEE C2-\. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

2..10. PROTECTIVE DEVICES

2..10..1. NOT USED

2..10..2. Fuses, Medium-Voltage, Including Current-Limiting

2..10..2..1. Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2..10..2..2. Ratings

Current-limiting power fuses shall have ratings in accordance with \-ANSI C37.46-\ and as follows:

Nominal voltage .....12470.

Rated maximum voltage .....15000.

Maximum symmetrical interrupting capacity .....To be based on coordination study.

Rated continuous current .....To be based on coordination study.

2..10..2..3. E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to \-ANSI C37.46-\.

2..10..2..4. C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

2..10..3. Fuses, Low-Voltage, Current-Limiting

2..10..3..1. Fuses shall conform to \-NEMA FU 1-\. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

2..10..3..2. Cartridge Fuses

Cartridge fuses, current-limiting type, Class K, L, RK1, RK5 and T shall have tested interrupting capacity not less than 100,000 200,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

a. Class L fuses shall conform to \-UL 198C-\.

b. Class K fuses shall conform to \-UL 198D-\.

c. Class R fuses shall conform to \-UL 198E-\.

d. Class T fuses shall conform to \-UL 198H-\.

2..11. SURGE ARRESTERS

Surge arresters shall comply with \-NEMA LA 1-\, \-IEEE C62.1-\, \-IEEE C62.2-\, and \-IEEE C62.11-\ and shall be provided where indicated. Arresters shall be distribution class, rated as shown. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type.

2..12. GROUNDING AND BONDING

2..12..1. Driven Ground Rods

Ground rods shall be copper-clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

2..12..2. Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be \-ASTM B 8-\ soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2..13. CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section \=03300=\ CAST-IN-PLACE STRUCTURAL CONCRETE.

2..14. PADLOCKS

Padlocks shall conform to \-ASTM F 883-\, Type EPC, size 2.

2..15. NOT USED

2..16. LIQUID DIELECTRICS

Liquid dielectrics for transformers and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 2 parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with \-ASTM D 923-\ and have tests performed per \-ASTM D 4059-\ at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 2 ppm shall be replaced.

2..17. FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

a. Transformers: Manufacturer's standard routine tests in accordance with \-IEEE C57.12.00-\.

b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with \-IEEE C57.98-\.

PART 3. EXECUTION

3..1. GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section \=16370=\ ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section \=16415=\ ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section \=02222=\ EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section \=03300=\ CAST-IN-PLACE STRUCTURAL CONCRETE.

3..1..1. Conformance to Codes

The installation shall comply with the requirements and recommendations of \-NFPA 70-\ and \-IEEE C2-\ as applicable.

3..1..2. Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3..1..3. Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

3..2. CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

3..2..1. Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain

the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

3..2..1..1. Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3..2..1..2. Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

3..2..1..3. Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3..2..1..4. Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

3..2..1..5. Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3..2..2. Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in handholes only, except as otherwise noted. Cable joints in medium-voltage cables shall be made in manholes or approved pullboxes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3..3. CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

3..4. NOT USED

3..5. DUCT LINES

3..5..1. Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a handhole, or between handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3..5..2. Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3..5..3. Concrete Encasement

Ducts requiring concrete encasements shall comply with \-NFPA 70-\, except that electrical duct bank configurations for ducts 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to \-IEEE C2-\. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in \-NFPA 70-\. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 5 feet below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

3..5..4. Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth of 30 inches, but not less than 30 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3..5..5. Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3..5..5..1. NOT USED

3..5..5..2. Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3..5..6. Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

3..6. HANDHOLES

3..6..1. NOT USED

3..6..2. NOT USED

3..6..3. NOT USED

3..6..4. Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

3..6..5. NOT USED

3..6..6. Ground Rods

A ground rod shall be installed at the handholes.

3..7. PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase transformers shall be installed with A,B,C phase sequence. Primary taps shall be set at 0%.

3..7..1. Concrete Pads

3..7..1..1. Construction

Concrete pads for pad-mounted electrical equipment may be either pre-fabricated or shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

3..7..1..2. Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and comform to the requirements of Section \=03300=\ CAST-IN-PLACE STRUCTURAL CONCRETE.

3..7..1..3. Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3..7..2. Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed as directed by the Contracting Officer. Padlocks shall comply with \-ASTM F 883-\, Type EPC, Size 2.

3..8. CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 10 feet apart and with 1 strap not more than 12 inches from any bend or termination. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit , near their point of exit from the conduit.

3..8..1. Pole Installation

Pole installation shall be in accordance with Section \=16370=\ ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

3..9. CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and 2.5 feet below finished grade as specified and provided under Section \=16415=\ ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

3..10. GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer, to the ground ring. Metallic frames and covers of handholes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3..10..1. Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.

b. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 18 inches, plus or minus 3 inches, below finished top of soil grade. Ground ring conductors shall be sized as shown .

3..10..2. Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with \-UL 467-\, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3..10..3. Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

3..10..4. Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper

conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

3..10..5. Handhole Grounding

Ground rods installed in handholes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

3..10..6. NOT USED

3..10..7. Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet.

3..11. FIELD TESTING

3..11..1. General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

3..11..2. Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3..11..3. \+Ground-Resistance Tests+

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in \-IEEE Std 81-\. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours

after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms.

d. Ground ring - 25 ohms.

3..11..4. NOT USED

3..11..5. \+Medium-Voltage Cable Test+

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with \-NEMA WC 7-\ or \-NEMA WC 8-\ for the particular type of cable installed. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3..11..6. \+Low-Voltage Cable Test+

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3..11..7. \+Liquid-Filled Transformer Tests+

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

3..11..8. NOT USED

3..11..9. NOT USED

3..11..10. NOT USED

3..11..11. NOT USED

3..11..12. \+Pre-Energization Services+

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

a. Pad-mounted transformers

3..11..13. \+Operating Tests+

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3..12. MANUFACTURER'S FIELD SERVICE

3..12..1. Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

3..12..2. Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3..13. ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

SECTION 16415

ELECTRICAL WORK, INTERIOR

SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C12.1-\	(1995) Code for Electricity Metering
\-ANSI C12.4-\	(1984; R 1990) Mechanical Demand Registers
\-ANSI C12.10-\	(1987) Electromechanical Watthour Meters
\-ANSI C39.1-\	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
\-ANSI C80.5-\	(1990) Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM B 1-\	(1990) Hard-Drawn Copper Wire
\-ASTM B 8-\	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
\-ASTM D 709-\	(1992) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C62.41-\	(1991) Surge Voltages in Low-Voltage AC Power Circuits
\-IEEE Std 81-\	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
\-IEEE Std 242-\	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
\-IEEE Std 399-\	(1990) Recommended Practice for Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA 250-\	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
\-NEMA AB 1-\	(1993) Molded Case Circuit Breakers and Molded Case Switches

\-NEMA FU 1-\	(1986) Low Voltage Cartridge Fuses
\-NEMA ICS 1-\	(1993) Industrial Controls and Systems
\-NEMA ICS 2-\	(1993) Industrial Control and Systems, Controllers, Contactors Overload Relays Rated not More Than 2,000 Volts AC or 750 DC
\-NEMA ICS 3-\	(1993) Industrial Systems
\-NEMA ICS 6-\	(1993) Industrial Control and Systems, Enclosures
\-NEMA MG 1-\	(1993; Rev 1) Motors and Generators
\-NEMA MG 10-\	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
\-NEMA OS 1-\	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
\-NEMA RN 1-\	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
\-NEMA WD 1-\	(1983; R 1989) General Requirements for Wiring Devices
\-NEMA WD 6-\	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code
\-NFPA 101-\	(1994) Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

\-UL-03-\	(1996) Electrical Construction Materials Directory
\-UL 1-\	(1993; Rev thru Jan 1995) Flexible Metal Conduit
\-UL 6-\	(1993; Rev March 96) Rigid Metal Conduit
\-UL 20-\	(1995) General-Use Snap Switches
\-UL 44-\	(1991; Rev thru Jun 1996) Rubber-Insulated Wires and Cables
\-UL 50-\	(1995) Enclosures for Electrical Equipment
\-UL 83-\	(1991; Rev thru Jun 1996) Thermoplastic-Insulated Wires and Cables

\-UL 98-\	(1994; R Oct 1995) Enclosed and Dead-Front Switches
\-UL 198B-\	(1995) Class H Fuses
\-UL 198C-\	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types
\-UL 198D-\	(1995) Class K Fuses
\-UL 198E-\	(1988; Rev Jul 1988) Class R Fuses
\-UL 198G-\	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
\-UL 198H-\	(1988; Rev thru Nov 1993) Class T Fuses
\-UL 198L-\	(1995; Rev May 1995) D-C Fuses for Industrial Use
\-UL 360-\	(1986; Rev thru Dec 1995) Liquid-Tight Flexible Steel Conduit
\-UL 467-\	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
\-UL 486A-\	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
\-UL 486C-\	(1991; Rev thru Oct 1996) Splicing Wire Connectors
\-UL 486E-\	(1994; Rev Aug 95) Equipment Wiring Terminal for Use with Aluminum and/or Copper Conductors
\-UL 489-\	(1996) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
\-UL 508-\	(1993) Industrial Control Equipment
\-UL 510-\	(1994) Insulating Tape
\-UL 512-\	(1993; R Dec 1995) Fuseholders
\-UL 514B-\	(1989; Rev thru Apr 1995) Fittings for Conduit and Outlet Boxes
\-UL 514C-\	(1988; Rev thru Jul 1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
\-UL 674-\	(1994; Rev thru Jul 1996) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations

\-UL 698-\	(1995; Rev thru Jul 1996) Industrial Control Equipment for Use in Hazardous (Classified) Locations
\-UL 797-\	(1993; Rev May 1995) Electrical Metallic Tubing
\-UL 817-\	(1994; Rev thru May 1996) Cord Sets and Power-Supply Cords
\-UL 845-\	(1995; Rev Feb 1996) Motor Control Centers
\-UL 854-\	(1996) Service-Entrance Cables
\-UL 869A-\	(1993; Rev Apr 1994) Reference Standard for Service Equipment
\-UL 886-\	(1994; Rev thru Jul 1995) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
\-UL 1004-\	(1994; Rev thru May 1996) Electric Motors
\-UL 1242-\	(1983; Rev thru Jul 1993) Intermediate Metal Conduit
\-UL 1449-\	(1985; Errata Apr 1986) Transient Voltage Surge Suppressors
\-UL 1660-\	(1994) Liquid-Tight Flexible Nonmetallic Conduit

1..2. GENERAL

1..2..1. Rules

The installation shall conform to the requirements of \-NFPA 70-\ and \-NFPA 101-\, unless more stringent requirements are indicated herein or shown. All electrical work on Pope AFB shall be performed by personnel authorized to engage in electrical contracting within the state of North Carolina and shall hold a North Carolina electrical license. An electrical license from another state may be acceptable if it qualifies under North Carolina's reciprocity process. A submittal of a certified copy of the electrical license shall be required.

1..2..2. Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Raceways, junction and outlet boxes shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

1..2..3. Special Environments

1..2..3..1. Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to \-NFPA 70-\ requirements for installation in damp or wet locations.

1..2..3..2. Hazardous Locations

Wiring and equipment in locations indicated shall be of the classes, groups, divisions, and suitable for the operating temperature; as indicated.

1..2..4. Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1..2..5. NAMEPLATES

1..2..5..1. Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with \-ASTM D 709-\ with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates: Motors and Motor Contol Center

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Motors	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed

above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1..2..6. As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish two sets of as-built drawings to the Contracting Officer.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Fault Current and Protective Device Coordination Study\; *GA*\.

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study, The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog\; *GA*\.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists\; *GA*\.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures\; *GA*\.

Installation procedures for rotating equipment and motor control center. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

SD-04 Drawings\

Interior Electrical Equipment\; *GA*\.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission.

Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

a. Motor control centers.

As-Built Drawings\; *FIO*\.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-08 Statements\

On-Site Test\; *GA*\.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports\

Factory Test Reports\; *GA*\.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Field Test Plan\; *GA*\.

A detailed description of the Contractor's proposed procedures for on-site test submitted 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports\; *GA*\.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

h. Final position of controls and device settings.

SD-13 Certificates\
Electrical License\; *GA*\.

Certified copy of the electrical contractors license.

Materials and Equipment\; *GA*\.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1..4. WORKMANSHIP

Materials and equipment shall be installed in accordance with \-NFPA 70-\, recommendations of the manufacturer, and as shown.

PART 2. PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..1. NOT USED

2..2. CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2..2..1. Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2..2..2. NOT USED

2..2..3. Insulation

Unless indicated otherwise, or required by \-NFPA 70-\, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to \-UL 83-\ or RHW conforming to \-UL 44-\, except that grounding wire may be type TW conforming to \-UL 83-\; remote-control and signal circuits shall be Type TW, THW or TF, conforming to \-UL 83-\.

2..2..4. Bonding Conductors

\-ASTM B 1-\, solid bare copper wire for sizes No. 8 AWG and smaller diameter; \-ASTM B 8-\, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2..2..5. Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, \-UL 854-\.

2..3. NOT USED

2..4. TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of \-IEEE C62.41-\ and be UL listed and labeled as having been tested in accordance with \-UL 1449-\. Surge suppressor ratings shall be 480 volts rms, operating voltage; 60 Hz; 3-phase; 4 wire with ground; transient suppression voltage (peak let-through voltage) of 1000 volts. Fuses shall not be used as surge suppression.

2..5. NOT USED

2..6. CIRCUIT BREAKERS

2..6..1. MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to \-NEMA AB 1-\ and \-UL 489-\. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2..6..1..1. Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with \-UL 486E-\. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2..6..1..2. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with \-NEMA AB 1-\. Ratings shall be coordinated with system X/R ratio.

2..6..1..3. NOT USED

2..6..1..4. Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit

protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2..7. MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to \-UL 508-\ and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of \-NFPA 70-\.

2..7..1. Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2..7..2. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA O	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2..8. CONDUIT AND TUBING

2..8..1. Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

\-UL 797-\

2..8..2. NOT USED

2..8..3. NOT USED

2..8..4. Flexible Conduit, Steel and Plastic

General-purpose type, \-UL 1-\; liquid tight, \-UL 360-\, and \-UL 1660-\.

2..8..5. Intermediate Metal Conduit

\-UL 1242-\.

2..8..6. PVC Coated Rigid Steel Conduit

\-NEMA RN 1-\.

2..8..7. Rigid Aluminum Conduit

\-ANSI C80.5-\ and \-UL 6-\.

2..8..8. Rigid Metal Conduit

\-UL 6-\.

2..9. CONDUIT AND DEVICE BOXES AND FITTINGS

2..9..1. Boxes, Metallic Outlet

\-NEMA OS 1-\ and \-UL 514C-\.

2..9..2. NOT USED

2..9..3. Boxes, Outlet for Use in Hazardous (Classified) Locations

\-UL 886-\.

2..9..4. Boxes, Switch (Enclosed), Surface-Mounted

\-UL 98-\.

2..9..5. Fittings for Conduit and Outlet Boxes

\-UL 514B-\.

2..9..6. Fittings For Use in Hazardous (Classified) Locations

\-UL 886-\.

2..10. CONDUIT COATINGS PLASTIC RESIN SYSTEM

\-NEMA RN 1-\, Type A-40.

2..11. CONNECTORS, WIRE PRESSURE

2..11..1. For Use With Copper Conductors

\-UL 486A-\.

2..12. ELECTRICAL GROUNDING AND BONDING EQUIPMENT

\-UL 467-\.

2..12..1. Ground Rods

Ground rods shall be of copper-clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2..13. ENCLOSURES

\-NEMA ICS 6-\ or \-NEMA 250-\ or \-UL 698-\ for use in hazardous (classified) locations, unless otherwise specified.

2..13..1. Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with \-UL 50-\, hot-dip, zinc-coated, if sheet steel.

2..14. NOT USED

2..15. LOW-VOLTAGE FUSES AND FUSEHOLDERS

2..15..1. Fuses, Low Voltage Cartridge Type

\-NEMA FU 1-\.

2..15..2. Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with \-UL 198C-\.

2..15..3. Fuses, Class K, High-Interrupting-Capacity Type

\-UL 198D-\.

2..15..4. Fuses, Class H

\-UL 198B-\.

2..15..5. Fuses, Class R

\-UL 198E-\.

2..15..6. Fuses, Class T

\-UL 198H-\.

2..15..7. Fuses for Supplementary Overcurrent Protection

\-UL 198G-\.

2..15..8. Fuses, D-C for Industrial Use

\-UL 198L-\.

2..15..9. Fuseholders

\-UL 512-\.

2..16. INSTRUMENTS, ELECTRICAL INDICATING

\-ANSI C39.1-\.

2..17. MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to \-NEMA MG 1-\ and \-UL 1004-\ for motors; \-NEMA MG 10-\ for energy management selection of polyphase motors; and \-UL 674-\ for use of motors in hazardous (classified) locations.

2..17..1. Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2..17..2. Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Motor Efficiencies

HP	Std. Efficiency	High Efficiency
1	77.0	85.5
1.5	78.5	85.5
2	78.5	85.5
3	78.5	88.5
5	82.5	88.5
7.5	84.0	90.0
10	85.5	90.0
15	85.5	91.0
20	87.5	92.0
25	88.5	92.0
30	88.5	92.0
40	88.5	92.0
50	89.0	92.5
60	89.0	92.5
75	89.0	95.5
100	90.0	93.5
125	91.0	94.5
150	91.0	94.5
200	91.0	94.5
250	91.0	94.5
300	91.0	94.5
350	91.0	94.5
400	91.0	94.5
500	91.0	94.5

2..18. MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2..18..1. General

\-NEMA ICS 1-\, \-NEMA ICS 2-\, \-NEMA ICS 3-\ and \-NEMA ICS 6-\, and \-UL 508-\ and \-UL 845-\.

2..18..2. Motor Starters

Combination starters shall be provided with circuit breakers, as indicated.

2..18..2..1. Reduced-Voltage Starters

Reduced-voltage starters shall be provided for polyphase motors 75 hp or larger. Reduced-voltage starters shall be of the solid state type having an adjustable time interval between application of reduced and full voltages to the motors.

2..18..3. Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2..18..4. Low-Voltage Motor Overload Relays

2..18..4..1. General

Thermal and magnetic current overload relays shall conform to \-NEMA ICS 2-\ and \-UL 508-\. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of \-NFPA 70-\. Standard units shall be used for motor starting times up to 7 seconds. Slow units shall be used for motor starting times from 8 to 12 seconds.

2..18..4..2. Construction

Manual reset type thermal relay shall be bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2..18..4..3. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise,

and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2..18..5. Automatic Control Devices

2..18..5..1. Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2..18..5..2. Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2..18..5..3. Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. The selector switches for the transfer pumps shall be the keyed type and shall be keyed alike with a selector switch mounted near the pump motor. See contract drawings.

c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2..18..6. Motor Control Centers

Control centers shall conform to the requirements of \-NEMA ICS 1-\, \-NEMA ICS 2-\, \-NEMA ICS 3-\ and \-NEMA ICS 6-\, and \-UL 508-\ and \-UL 845-\. Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be \-NEMA ICS 2-\, Class 1, Type B. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Motor control centers shall be provided with a full-length ground bus bar.

2..19. NOT USED

2..20. NOT USED

2..21. Service Entrance Equipment

\-UL 869A-\.

2..22. SPLICE, CONDUCTOR

\-UL 486C-\.

2..23. NOT USED

2..24. SNAP SWITCHES

\-UL 20-\.

2..25. TAPES

2..25..1. Plastic Tape

\-UL 510-\.

2..25..2. Rubber Tape

\-UL 510-\.

2..26. NOT USED

2..27. NOT USED

2..28. WATTHOUR METERS, UTILITY REVENUE

Watthour meters shall conform to \-ANSI C12.1-\ and \-ANSI C12.10-\, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 15-minute, cumulative form, demand register meeting \-ANSI C12.4-\ and provided with not less than two and one-half stators.

2..29. NOT USED

2..30. \&INSTRUMENT TRANSFORMERS

2..30..1. General

Instrument transformers shall comply with \-ANSI C12.11-\ and \-IEEE C57.13-\. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

2..30..2. Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than 2.0. Other thermal and mechanical ratings of current transformer and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit

protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2..30..2..1. NOT USED

2..30..2..2. NOT USED

2..30..2..3. NOT USED

2..30..2..4. Current Transformers for kWH and Demand Metering (Low Voltage)

Current transformers shall conform to \-IEEE C57.13-\. Provide current transformers with a metering accuracy Class of 0.3, with a minimum RF of 3.0 at 30 degrees C, with 600-volt insulation, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted on the transformer low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters.

2..30..2..5. Voltage Transformers

Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of .3. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.&\

2..31. WIRING DEVICES

\-NEMA WD 1-\ for wiring devices, and \-NEMA WD 6-\ for dimensional requirements of wiring devices.

2..32. NOT USED

2..33. COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2..33..1. Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the nearest upstream device in the existing source system and extend through the downstream devices at the load end.

2..33..2. Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall coordinate with the commercial power company for fault current availability at the site.

2..33..3. Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provide, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2..33..4. Fault Current Analysis

2..33..4..1. Method

The fault current analysis shall be performed in accordance with methods described in \-IEEE Std 242-\, and \-IEEE Std 399-\.

2..33..4..2. Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

2..33..4..3. Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2..33..5. Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situation where system coordination is not achievable due to device limitations (an analysis of any device curves which order overlap); coordination between upstrean and downstrean devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2..33..6. Study Report

a. The report shall include a narrative: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device curves and protective device ratings and settings.

d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculations performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3. EXECUTION

3..1. GROUNDING

Grounding shall be in conformance with \-NFPA 70-\, the contract drawings, and the following specifications.

3..1..1. Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in \-IEEE Std 81-\. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 3 additional rods not less than 6 feet on centers, or if sectional type rods are used, 2 additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use \-UL 467-\ approved connectors.

3..1..2. NOT USED

3..1..3. Grounding Conductors

A green equipment grounding conductor, sized in accordance with \-NFPA 70-\ shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded

into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per \-NFPA 70-\. When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3..2. WIRING METHODS

Wiring shall conform to \-NFPA 70-\, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit electrical metallic tubing intermediate metal conduit . Wire fill in conduits shall be based on \-NFPA 70-\ for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

3..2..1. Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to \-NFPA 70-\. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by \-NFPA 70-\. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by \-NFPA 70-\. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3..2..1..1. Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than \~254 mm^\ \~10 inches~\ of slack shall be left at each end of the pull wire.

3..2..1..2. Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the

floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3..2..1..3. Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3..2..1..4. NOT USED

3..2..1..5. Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3..2..1..6. Supports

Except where otherwise permitted by \-NFPA 70-\, conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means will not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by \-NFPA 70-\, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by \-NFPA 70-\, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3..2..1..7. Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with \-NFPA 70-\ definitions.

3..2..2. NOT USED

3..2..3. NOT USED

3..2..4. Cables and Conductors

Installation shall conform to the requirements of \-NFPA 70-\. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3..2..4..1. Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3..2..4..2. Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used. .

3..2..4..3. NOT USED

3..2..4..4. NOT USED

3..2..4..5. Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

3..2..4..6. Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel

designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for three-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
120/240-volt, 1-phase: Black and red.

b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3..3. BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by \-NFPA 70-\ for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by \-NFPA 70-\. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and must not exceed the maximum specified for that box in \-UL-03-\. Only boxes listed in \-UL-03-\ shall be used in fire rated walls.

3..3..1. Box Applications

Each box shall have not less than the volume required by \-NFPA 70-\ for number of conductors enclosed in box. Boxes for metallic raceways, 4 by 4 inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 1 or as shown.

Boxes in other locations shall be sheet steel. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3..3..2. Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3..3..3. Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3..3..4. Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3..4. DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet

steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be ivory . Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3..5. NOT USED

3..6. NOT USED

3..7. SERVICE EQUIPMENT

Service-disconnecting means shall be of the enclosed molded-case circuit breaker type with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3..8. NOT USED

3..9. FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

3..9..1. Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

3..9..2. Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK1 RK5 shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

3..9..3. NOT USED

3..9..4. NOT USED

3..9..5. Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3..10. UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and \-NFPA 70-\.

3..11. NOT USED

3..12. MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3..13. MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a

double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3..13..1. Reduced-Voltage Controllers

Reduced-voltage controllers shall be provided for polyphase motors 75 hp or larger. Reduced-voltage starters shall be of the solid state type.

3..13..2. Motor Control Centers

Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be \-NEMA ICS 2-\, Class 1, Type B. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with circuit breakers. Motor control centers shall be provided with a full-length ground bus bar.

3..13..3. Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with \-NEMA ICS 2-\ for rating designation B300.

3..13..4. Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

3..14. MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by \-NFPA 70-\ even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3..15. NOT USED

3..16. NOT USED

3..17. NOT USED

3..18. EQUIPMENT CONNECTIONS

All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3..18..1. Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with \-NFPA 70-\, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3..18..2. Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

3..19. CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3..20. PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section \=09900=\ PAINTING, GENERAL.

3..21. REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3..22. \+FIELD TESTING+

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically

waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3..22..1. Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3..22..2. \+Ground-Resistance Tests+

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in \-IEEE Std 81-\. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms .

b. Grid electrode - 25 ohms.

3..22..3. Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 48 hours before the site is ready for inspection.

3..22..4. \+Cable Tests+

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3..22..4..1. NOT USED

3..22..4..2. Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3..22..5. NOT USED

3..22..6. \+Motor Tests+

a. Phase rotation test to ensure proper directions.

b. Operation and sequence of reduced voltage starters.

c. High potential test on each winding to ground.

d. Insulation resistance of each winding to ground.

e. Vibration test.

f. Dielectric absorption test on motor and starter.

3..22..7. NOT USED

3..22..8. NOT USED

3..22..9. \+Circuit Breaker Tests+

The following field tests shall be performed on circuit breakers.

3..22..9..1. NOT USED

3..22..9..2. NOT USED

3..22..9..3. Circuit Breakers, Molded Case

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

3..22..10. Motor Control Centers

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Manual and electrical operational tests.

3..23. \+OPERATING TESTS+

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the

specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3..24. FIELD SERVICE

3..24..1. Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training shall be submitted.

3..24..2. Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3..25. ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

SECTION 16670

LIGHTNING PROTECTION SYSTEM

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1990) National Electrical Code
\-NFPA 780-\	(1995) Lightning Protection Code

UNDERWRITERS LABORATORIES (UL)

\-UL-03-\	(1992) Electrical Construction Materials Directory
\-UL 96-\	(1985; Rev thru Dec 1988) Lightning Protection Components
\-UL 96A-\	(1982; Rev thru Jul 1990) Installation Requirements for Lightning Protection Systems
\-UL 467-\	(1984; Rev thru Nov 1986) Grounding and Bonding Equipment
\-UL 486A-\	(1991; R Oct 91) Wire Connectors and Soldering Lugs for Use with Copper Conductors

1..2. GENERAL REQUIREMENTS

1..2..1. Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

1..2..2. System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved design. The lightning protection system shall conform to \-NFPA 70-\ and \-NFPA 780-\, \-UL 96-\ and \-UL 96A-\, except where requirements in excess thereof are specified herein.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Lightning Protection System\; *GA*\.

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

SD-13 Certificates\

Materials and Equipment\; *GA*\.

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in \-UL-03-\ will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted. A letter of findings shall be submitted certifying UL inspection of lightning protection systems provided on the following facilities: Pump House

PART 2. PRODUCTS

2..1. MATERIALS

2..1..1. General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

2..1..2. Main and Secondary Conductors

Conductors shall be in accordance with \-NFPA 780-\ and \-UL 96-\ for Class I, Class II, or Class II modified materials as applicable.

2..1..2..1. Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall

be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than No. 1/0 AWG.

2..1..2..2. Aluminum

Aluminum shall not contact the earth nor shall it be used in any other manner that will contribute to rapid deterioration of the metal. Appropriate precautions shall be observed at connections with dissimilar metals. Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least equivalent to strength and cross-sectional area of a No. 4 AWG aluminum wire. If perforated strips are used, the strips shall be as much wider than solid strips, as the diameter of the perforations.

2..1..3. Air Terminals

Terminals shall be in accordance with \-UL 96-\ and \-NFPA 780-\. The tip of air terminals on buildings used for manufacturing, processing, handling, or storing explosives, ammunition, or explosive ingredients shall be a minimum of 2 feet above the ridge parapet, ventilator or perimeter. On open or hooded vents emitting explosive dusts or vapors under natural or forced draft, air terminals shall be a minimum of 5 feet above the opening. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides, not less than one-half the height of the terminal.

2..1..4. Ground Rods

Rods made of copper-clad steel shall conform to \-UL 467-\. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length.

2..1..5. Clamp-Type Connectors

Connectors for splicing conductors shall conform to \-UL 96-\, class as applicable, and \-UL 486A-\, Class 2, style and size as required for the installation.

2..1..6. Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to \-UL 96-\, classes as applicable.

PART 3. EXECUTION

3..1. INTEGRAL SYSTEM

3..1..1. General Requirements

The lightning protection system shall consist of air terminals, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

3..1..1..1. Air Terminals

Air terminal design and support shall be in accordance with \-NFPA 780-\. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.

3..1..1..2. NOT USED

3..1..1..3. Down Conductors

Down conductors shall be electrically continuous from air terminals to grounding electrodes. Down conductors shall be protected where necessary, to prevent mechanical injury to the conductor.

3..1..1..4. NOT USED

3..1..1..5. Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3..1..1..6. Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 3 feet, nor more than 8 feet, from the structures foundation. The complete installation shall have a total resistance to ground of not more than 25 ohms . Ground rods shall be tested individually prior to connection to the system and the system as a whole shall be tested not less than 24 hours after rainfall. When the resistance of the complete installation exceeds the specified value or two ground rods individually exceed 25 ohms, the Contracting Officer will be notified immediately. A counterpoise, where required, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet deep at a distance not less than 3 feet nor more than 8 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous.

3..2. NOT USED

3..3. NOT USED

3..4. INTERCONNECTION OF METAL BODIES

Metal bodies of conductance shall be protected if not within the zone of protection of an air terminal. All metal bodies of conductance having an area of 400 square inches or greater or a volume of 1000 cubic inches or greater shall be bonded to the lightning protection system using main size conductors

and a bonding plate having a surface contact area of not less than 3 square inches. Provisions shall be made to guard against the corrosive effect of bonding dissimilar metals. Metal bodies of inductance shall be bonded at their closest point to the lightning protection system using secondary bonding conductors and fittings. A metal body that exceeds 5 feet in any dimension, that is situated wholly within a building, and that does not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

3..5. NOT USED

3..6. NOT USED

3..7. NOT USED

3..8. SEPARATELY MOUNTED SHIELDING SYSTEM, OVERHEAD GROUND-WIRE TYPE

This type of protection shall consist of two or more poles electrically connected to each other by overhead conductors. Where the poles are made of a nonconducting material an air terminal shall be mounted to the top of each pole and shall extend not less than 2 nor more than 5 feet above the top of the pole. Down conductors shall be run down the side of the pole. Resistance to ground shall not exceed 25 ohms. The height of the poles shall be sufficient to provide a clearance of not less than 6 feet between the overhead ground wire and the highest projection of the building. When grounding is required, a ground rod shall be driven approximately 6 feet from the base of each pole. When the combined measured resistance to ground of the pole and ground rod exceeds 25 ohms, the Contracting Officer will be notified immediately. When a counterpoise is used, the entire system resistance requirement of 25 ohms or less need not be met.

3..9. INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

SECTION 16906

PUMP CONTROL AND ANNUNCIATION SYSTEM

SECTION 16906

PUMP CONTROL AND ANNUNCIATION SYSTEM

PART 1 - GENERAL

1.1 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1.1 American National Standards (ANSI) Publications

C37.90-78 (R 1979)	Relays and Relay Systems Associated With Electric Power Apparatus
C62.41-80	Guide for Surge Voltages in Low Voltage AC Power Circuits

1.1.2 Institute of Electrical and Electronics Engineers, Inc. (IEEE) Publications

472-74 (R 1979)	Guide for Surge Withstand Capability (SWC) Tests

1.1.3 National Electrical Manufacturer's Association (NEMA) Publications

ICS 1-78 (R 1-4, 1983)	General Standard for Industrial Control and Systems
ICS 2-83 (R 3-86)	Standards for Industrial Control Devices, Controllers and Assemblies
ICS 3-83	Industrial Systems
ICS 4-83	Terminal Blocks for Industrial Control Equipment and Systems
ICS 6-83 (R 1, 1983)	Enclosures for Industrial Controls and Systems
LS 1	Low Voltage Surge Protective Devices
250-87	Enclosures for Electrical Equipment (1,000 Volts Maximum)

1.1.4 National Fire Protection Association (NFPA) Publication

70-1996	National Electrical Code

1.1.5 Instrument Society of America (ISA)

Standards for Loop Diagrams

1.1.6 Underwriters' Laboratory Inc. (UL) Publication

1449-87 Transient Surge Suppression

1.2 GENERAL REQUIREMENTS

Section \=16415=\ ELECTRICAL WORK INTERIOR applies to this section, with the additions and modifications specified herein. The Control System Contractor shall be responsible for the entire control system. The Control Contractor shall coordinate with **all** contractors supplying the field devices. The Control Contractor shall be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices.

1.3 SUBMITTALS

1.3.1 GENERAL

Data shall be submitted in accordance with the overall requirements detailed in Section \=01330=\ SUBMITTAL PROCEDURES and the specific requirements of this section. Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Documents shall consist of a complete list of equipment and materials, manufacturer's descriptive and technical literature, brochures, catalog cuts, performance specifications, diagrams, and other material as stated in subsequent subparagraphs. The Contractor shall submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

1.3.2 Submittals

As a minimum the following must be submitted in accordance with the specific subparagraphs noted:

SD-01 Data\

Experience and Qualifications\; *GA1*\

Pump Control Panel\; *GA1*\

Control Panel Components\; *GA1*\

Control System Hardware and Software\; *GA1*\

Supplementary documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents shall consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions.

SD-04 Drawings\

Pump Control Panel (PCP)\; *GA1*\

Control Panel Components\; *GA1*\

Control System Hardware and Software\; *GA1*\

Control Ladder Diagram\; *GA1*\

Shop Drawings\; *GA1*\

Detail drawings consisting of manufacturer's descriptive and technical data, catalog cuts, special installation instructions, applicable schematic diagrams, and equipment layout and anchorage and conduit runs, anchorage, and support. Two sets of as-built drawings, within 30 days following the project completion or turnover.

Submit shop drawings showing dimensions, weights, construction details for each enclosure. Drawings shall indicate size, location and mounting methods for each major component of the pump control panel. Shop drawings shall indicate, but not be limited to, the following:

a. Material, thicknesses, finishes.
b. Overall dimensions, front view, and sectional views.
c. System schematic, including flow diagrams, I/O list, and point- to-point wiring diagrams, set points, operating ranges, and indicators. Wiring diagrams shall have terminals identified.
d. General arrangement drawings showing location of equipment, interior and on door panels.
e. Bill of materials.
f. Installation instructions.
g. Written control sequence covering all inputs, outputs, and control scheme.
h. Wiring schematic and layout of the PLC.
i. Generic, functional description of each control component.

SD-07 Schedules\

List of Equipment and Materials\; *FIO*\

A complete itemized listing of equipment and material proposed for incorporation into the work. Each itemization shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

SD-09 Reports\

Certified Pump Control Panel Shop Test Report\; *FIO*\

Notify the Representative of the Contracting Officer 30 days prior to the final test. The Contracting Officer may require the presence of a Government witness at the final test. Submit certified Control Panel test report within 15 days after successful completion of test.

SD-18 Records\

Plan For Instructing Operating Personnel\; *GA1*\

Tools and Spare Parts\; *GA*\

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA1*\

Six copies of O&M manuals, within 7 calendar days following the completion of factory tests.

Operational and Maintenance manuals shall be furnished following the completion of factory tests and shall include:

a. Pump Control Panel assembly including interior and exterior equipment layout.

b. All documents previously submitted and approved with all comments and field changes annotated.

c. Complete description of the sequence of operation including Specification 16920 PLC CONTROL SYSTEM SEQUENCE OF OPERATION and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.)

d. Complete listing of all programing of the PLC.

e. Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

f. Complete guide outlining step-by-step procedures for system startup and operation.

g. Complete troubleshooting guide which lists possible operational problems and corrective action to be taken.

h. Complete maintenance manual for all equipment supplied.

i. Spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

j. The above shall incorporate all as-built conditions.

Documents shall be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.4 SHOP TESTS

Certified Pump Control Panel Shop Test Report\

The manufacturer shall shop test the Control Panel. The procedure shall include simulation of field components and shall provide for fully testing the Pump Control Panel and annunciator system as a unit before delivery to the project site. The test shall, in a comprehensive manner, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. The test shall be performed prior to shipment to the site and

problems detected shall be corrected and the Control Panel retested prior to shipment to the job site. The testing and correction sequence shall be repeated until no problems are revealed and then two additional successful tests shall be performed. Submit certified test report within 15 days after completion of the test. The report shall include a statement that the Pump Control Panel perform as specified.

The Contractor shall notify the Government 30 Days prior to the final test date. The Contracting Officer may require a Government witness at the final test before the Control Panel is shipped to the site.

1.5 SYSTEM OVERVIEW

1.5.1 General

The facility consists of Railcar Offload/Transfer pumps to be installed under this contract and prepartion i.e. controls for Truck Offload pumps to be installed under a future contract. The transfer pumps are used to unload fuel from railroad cars and transfer fuel between storage tanks and transfer fuel from storage tanks across the ramp to the Type III hydrant system. The Truck off-load pumps will unload fuel from Trucks and can also transfer fuel across the ramp to the Type III system. The redundant programmable logic controllers (PLCs) will control the start and stops of the transfer and off-load pumps per pushbutton control stations, level sensor control in the air eliminators, and flow switches.

1.5.2 Interface Components

All power supplies, interface devices and all work required for a fully functional panel conforming to design intent herein shall be provided. Each component shall be compatible with interconnected components, and shall perform the function for which it was designed. Installation and operation shall be in accordance with the manufacturer's recommended procedures and requirements.

1.6 *EXPERIENCE AND QUALIFICATIONS*\

Submit the following data for approval to the Representative of the Contracting Officer :

a. Certification stating that the Control Contractor has built and installed at least five PLC-based systems for controlling pumps.

b. Certification that the control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.7 WARRANTY

The Pump Control Panel including devices, hardware and software shall be warranted for a period of 1 year from the date of acceptance of the system by the Government. This warranty service shall include parts and labor service for equipment supplied under this specification. Upon notification by the

Government of system or component failure, the Contractor shall respond at the site with necessary parts within 2 working days.

PART 2 PRODUCTS

2.1 *PUMP CONTROL PANEL (PCP)*

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA 250 as applicable. Wiring methods and practices shall be in accordance with Joint Industrial Council recommendations as applicable. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by the same manufacturer.

The PCP shall include all required resident software programs and hardware to provide the specified sequence of operation. All software floppy disks including programming manuals shall be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

2.1.1 Enclosure

The PCP enclosure shall be a freestanding NEMA 250, Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams shall be continuously welded and there shall be no drilled holes or knockout prior to delivery to the job site. The control panel dimensions shall be a maximum of 90 inches high, a maximum of 36 inches wide, and a maximum of 24 inches deep. The panel shall be shipped fully assembled in one piece and shall have removable lifting eyes. The interior surface of the panel shall be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces shall have standard factory finish. Access for the PCP shall be front only and shall consist of hinged door having a 3-point latching mechanism. The door shall open to a minimum of 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware shall be installed such that servicing of one component shall not require removal or disconnection of other components. No clearance shall be required between the back of the panel and the room walls. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation

The PCP shall have forced air ventilation to maintain interior air temperature no greater than 78EF. Ventilating units shall have replaceable air filters.

2.1.3 Grounding

The control panel shall have a tin plated copper equipment ground bar. The bar shall have a minimum of twenty grounding screws. The ground bar shall be connected to the counterpoise.

2.1.4 Graphical Display

The door shall depict the process fuel flow schematically as indicated on the drawings. The process schematic graphic representation shall utilize conventional symbols when possible. Symbols and flow lines shall be sized and spaced so as to provide a clear representation of the system process.

2.2 PUMP *CONTROL PANEL COMPONENTS*

2.2.1 Standard Indicator Light

Lights shall be heavy duty, NEMA 13, 22.5 mm mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs shall be used. Indicator lights shall have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights shall be a push to test (lamp) type.

2.2.2 Mini-Indicator Light

Lights shall be heavy duty, NEMA 13, 18 mm to 12 mm mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs shall be used. Indicator lights shall have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights shall be a push to test (lamp) type. 12 mm minimum LED type lamp with legend plate may be provided instead of push to test type. If a LED type lamp is provided a panel LED lamp test button shall be provided.

2.2.3 Panel switches

Selector switches shall be heavy duty, NEMA 13, round, and utilize a 22.5 mm mounting hole. The number of positions as indicated on the drawings, non-illuminated lever operated selector switch.

Non-illuminated pushbuttons shall be heavy duty, NEMA 13, round, utilize a 22.5 mm mounting hole, number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch shall be a red mushroom head, 40 mm diameter, momentary contact type.

Illuminated pushbuttons shall be heavy duty, NEMA 13, round, utilize a 22.5 mm mounting hole, number and type of contacts as indicated on the drawings or elsewhere in the specifications, indicating light operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs shall be used. Lens color as indicated on drawings.

Switches shall be rated 600 volt, 10 amperes continuous. Legend plates shall be provided with each switch with words as indicated on the drawings.

2.2.4 Elapsed Time Meter

The elapsed time meter shall be ruggedly constructed, UL Recognized, with true time mechanisms for recording the ON time of motors. The display shall display a minimum of six digits (99,999.9) and measure hours. The display face shall have approximate dimensions of 65 mm x 65 mm.

2.2.5 Nameplates

Nameplates shall be made of laminated plastic with black outer layers and a white core. Edges shall be chamfered. Nameplates shall be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.2.6 Alarm Annunciator

The Alarm Annunciator shall provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator shall be completely solid state with no moving parts. The annunciator shall be furnished with cabinet and hardware appropriate for flush mounting on the side of the control panel. An integral power supply shall operate on 120 volts, 60 Hertz. The annunciator shall have windows arranged in a matrix configuration (rows and columns). The minimum number of windows shall correspond to the number of alarm points, plus 15% spare. Each window shall be at least 25 mm high by 40 mm wide and shall have rear illuminated translucent engraved nameplate. Lettering shall be at least 4 mm inches high. System lamp voltage shall be 24 to 28 volts dc. Windows for critical faults shall be red and windows for non-critical faults shall be white. See drawings for layout and alarms.

2.2.7 Alarm Horn and Buzzer

The alarm horn shall be a weatherproof vibrating horn mounted on the exterior wall of the Pumphouse producing 100 dB at 3100 mm. The alarm buzzer shall be mounted on the PCP producing 70 dB at 3100 mm.

2.2.8 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the Control Panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.2.9 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices shall be installed in the Control Panels to minimize effects of nearby lightning strikes, switching on and off motors and other inductive loads. Transient protection shall meet the requirements of ANSI C62.41, NEMA LS1, and shall comply with UL 1449, and shall be UL listed.

TVSS shall be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: power supplies (e.g. 24 volt), fans, relays, lights, switches, etc. TVSS shall also be provided for PLC I/O originating outside of the building.

2.2.10 Power Conditioner (Constant Voltage Transformer Type)

Provide a power conditioner for each PLC system and the field device power supplies. Power conditioner output capacity shall be sufficient to drive all equipment connected there to plus 25% spare capacity.

Input voltage shall be 120 volts (nominal), 1 phase, 60 Hertz.

Output voltage regulation shall be +/-5.0% for the following conditions:

a. 20% to 100% load on output.
b. Input voltage variation of -15% to +10%.
c. Constant load power factor between 80% and 100%.

Response time shall be 1.5 cycles or less.

2.2.11 Miscellaneous Power Supplies

Certain field devices may require power other than 120VAC (i.e. 24VDC). The power supplies shall be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting. The power supplies shall be sized for the load plus 10 percent.

2.3 *CONTROL SYSTEM HARDWARE AND SOFTWARE*\

Control shall be performed in a digital manner by the Programmable Logic Controller and converted to electric signals to monitor and operate field devices. The controllers and I/O modules shall function properly at temperatures between 32 and 122 degrees F, zero and 95 percent relative humidity (non-condensing), and input voltage between plus 10 and minus 15 percent at 60 Hertz, and stored at temperatures between minus 4 and plus 140 degrees F and zero and 95 Percent Relative humidity (non-condensing). The PLC modules shall comply with the Federal Communication Commission's Standard 15J Part A for radio noise emissions.

2.3.1 Programmable Logic Controllers (PLCs)

The Contractor shall provide solid-state programmable logic controllers designed for use in industrial applications. The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. Each controller shall include a CPU, input/output scanner, input modules, output modules, memory (RAM and EEPROM), communication modules, a power supply, its application software, and all power and interface cables necessary to function as a complete and operable programmable controller system.

2.3.1.1 Assembled Systems

The Contractor shall assume single source responsibility for the PCP system assembly and all supporting field devices. An assembled system shall include mounting and wiring of relays, transformers, disconnecting means, and other control devices as specified herein.

2.3.1.2 The programmable controller system shall be a modular, field expandable design allowing the system to be tailored to the process control application. The capability shall exist to allow for expansion to the system by the addition of hardware and/or user software.

2.3.1.3 The processor plus input and output circuitry shall be of a modular design with interchangeability provided for all similar modules. Modules are defined as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot. All modules within the system shall be mechanically interlocked to prevent insertion or removal of modules under power.

2.3.1.4 The CPU shall be a self-contained unit, and will provide Ladder Rung program execution and support local programming. This device will also supply I/O scanning and inter-processor and peripheral communication functions.

2.3.1.5 The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating an indicator when no fault is detected and a separate indicator when a fault is detected.

2.3.1.6 The main CPU front panel shall include a connector that provides inter-processor communication to peripheral support devices. This connector will support communication to a programming device up to 10,000 cable feet away, at no less than 57.6 Kbaud. If the cable length is reduced, then the transmission rate may increase.

2.3.1.7 The main chassis front panel shall include two-color indicators showing the following status information:

a. If power is applied to the CPU
b. Program or Run mode of the CPU
c. The run/fault status of the CPU
d. Enabled/disabled state of outputs
e. State of the I/O adapters
f. If a remote device is talking via the inter-processor communications link

2.3.1.8 Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. This shall be accomplished by the use of a EEPROM module.

2.3.2 Program Storage/Memory Requirements

2.3.2.1 The program storage medium shall be of a solid state RAM (volatile) type with EEPROM memory module back-up. 2.3.2.2 The Contractor shall provide adequate main memory for data storage and an additional 150% for future use. The programmable controller system shall be capable of storing the following data types:

a. External Output Status
b. External Input Status
c. Timer Values
d. Counter Values
e. Signed Integer Numbers (16 bit)
g. Decimal Numbers
h. Binary Numbers
i. Direct and Indexed Addressing
j. Internal Processor Status Information
k. ASCII and Control Structures

The above listed data types shall be distinguishable to the CPU by the addressing format. Management of the data types into memory subsections shall be an automatic function of the CPU operating system.

Any data can be displayed in Binary, Decimal, or ASCII radices.

2.3.2.3 The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

2.3.3 Program Requirements

2.3.3.1 The programming format shall be traditional relay ladder diagram.

2.3.3.2 There shall be a means to indicate contact or output status of the contact or output on the operator interface panel. Each element's status shall be shown independently, regardless of circuit configuration.

2.3.3.3 The program shall be full featured in its editing capabilities. (e.g. change a contact from normally open to normally closed, add instructions, interlay rungs anywhere in the program, delete an individual ladder diagram rung, change addresses, etc.).

2.3.3.4 A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal, user program, or message generation.

2.3.3.5 Latch functions shall be internal and programmable.

2.3.3.6 The system shall have a minimum of 6K of memory dedicated to timers and counters. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

2.3.3.7 Timer instructions shall include selectable time bases in increments of 1.0 second and 10 milliseconds. The minimum timing range of each timer shall be from 0 to 32,000 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

2.3.3.8 The programmable controller shall use a signed integer format ranging from minus 32,768 to plus 32,767 for data storage of the counter preset and accumulated values.

2.3.3.9 The programmable controller shall have signed math functions consisting of addition, subtraction, multiplication, and division.

2.3.3.10 The programmable controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

2.3.3.11 In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system.

2.3.3.12 The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered. At a minimum, comments shall be added to indicate major sections of the program.

2.3.3.13 The capability shall exist for adding, removing, or modifying ladder logic rungs during program execution.

2.3.3.14 It shall be possible to manually set (force) either on or off all hardware input or output points from the hand-held programmer or the main chassis front panel. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

2.3.3.15 The execution of the program logic shall be accelerated by scanning the rung only until a positive decision as to the state of the outputs has been made. In many cases this will mean skipping over logic elements if the output condition has been predetermined.

2.3.3.16 A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

2.3.3.17 An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 65 seconds.

2.3.3.18 The CPU shall support indexed and indirect addressing of inputs and outputs, along with all data table words (integer, binary, timers, and counters) for the software instruction set.

2.3.4 Input/Output (I/O) Modules

The Contractor shall provide all required I/O modules to provide the inputs and outputs shown on the drawings and to comply with the sequence of operations. The Contractor shall also provide a minimum of 20% (round up for calculation) spare input and output points of each type provided.

2.3.4.1 Type of Construction

Controllers shall be of modular construction to facilitate easy replacement of functional components. Each input or output module shall be a self-contained unit housed within an enclosure.

2.3.4.2 The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any, programmable controller manufactured by the supplier. I/O slots shall be provided for all required modules.

2.3.4.3 During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel.

2.3.4.4 Isolation

Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field

devices. I/O equipment shall be rack mounted and shall be protected against surge in accordance with IEEE 472.

2.3.4.5 It shall be possible to replace any input or output module without disturbing field wiring.

2.3.4.6 Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

2.3.4.7 Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module.

2.3.4.8 Terminal Strips

All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

2.3.4.9 All input/output modules shall be color coded and titled with a distinctive label.

2.3.4.10 A communication module (I/O module) shall be available to provide an interface between the controller and an ASCII peripheral device. Allowed electrical interfaces are RS-232-C, RS-422, RS-485, and current loop.

2.3.5 Power Supply Module

The programmable logic controller and remote I/O racks shall operate in compliance with an electrical service of 120 VAC, single phase, 57 to 63 Hz or 24 VDC or 125 VDC.

2.3.5.1 The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125 percent of its rated current.

2.3.5.2 The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

2.3.5.3 The programmable controller power supply module shall include diagnostic indicators mounted in a position to be easily viewed by the user. These indicators shall provide the operator with the status of AC and DC power applied. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

2.3.5.4 At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

2.3.6 Hand-Held Programmer

The PLC manufacturers hand-held programmer shall be provided that can develop, debug, and monitor logic programs, monitor data tables, and configure PLC and I/O parameters. The connection shall be through a 1800 mm cable that connect to the PLC serial port. The cable also provides power connections to the programmer, and provides a signal that tells the PLC that the programmer is attached. The programmer can be connected or disconnected to a PLC that is powered-up.

2.4 QUALITY REQUIREMENTS

2.4.1 The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2-230, NEMA ICS 3-304-42, section 2 of IEEE 472-1974 and ANSI C37.90A-1974.

2.4.2 All completed units shall be subjected to a burn-in test of 60 degrees C for at least 96 hours.

2.4.3 Controllers shall be of modular construction to facilitate easy replacement of functional components.

PART 3 EXECUTION

3.1 CONTROL PANEL COMPONENTS

It is intended that process controlling devices except field devices and motor controllers be attached to or mounted within the Control Panel enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

3.1.1 PLC - General

The PLC shall be rack mounted within the control panel enclosure and shall be easily removable. Disturbance of individual terminations shall not be required for removal or insertion.

3.1.2 Sequence of Operation

See Specification 16920 PLC CONTROL SYSTEM SEQUENCE OF OPERATION and drawings for the programming of the PLC.

3.1.3 Programs

The Contractor shall provide a copy of all working programs (i.e. PLC logic) on 3-1/2 inch floppy disks as well as a printer program listing. At system start up, debug, and testing the Contractor shall provide personnel, on site, to provide technical assistance, program fine tuning, and to demonstrate the system.

3.1.3.1 The Contractor (programmer) shall provide rung comments (documentations) in the ladder logic program. Each device, on the ladder, shall be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc.. Rung comments shall be provided for input and output rungs. The programmer shall also provide a comment describing the function of each rung.

3.1.4 Input/Output (I/O) Modules

Interconnecting wiring between PLC modules and field wiring terminal blocks shall be completely installed prior to shipment to the job site. The control panel manufacturer shall provide the field electrical contractor a terminal block pin-out data, so he can wire the field devices easily and correctly to the control panels.

3.1.5 Field Device Power

The Contractor shall provide and install a 120VAC circuits (number as required) connected to terminal blocks and miscellaneous power supplies in the control panels. All field devices which require power and are controlled or monitored from the control panel shall be supplied from power sources in the control panels.

3.1.6 System Grounding

Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.

3.2 *CONTROL LADDER DIAGRAM*\

The Control Contractor shall submit a detailed control ladder diagram for the control panel. The diagram at a minimum shall show:

a. Power connections between surge arresters, power supplies, PLCs, etc.
b. Power and control connections between field devices and PLC I/O modules.

The diagram shall be clear and readable and preferable drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings shall be redrafted to include all as-built conditions. These updated drawing shall be included in the O & M Manuals and appropriate sections of the drawings placed in a data pocket located in the control panel.

3.3 INSTALLATION

Installation shall conform to the manufacturer's drawings, written recommendations and directions.

3.3.1 Field Service

The Contractor shall provide technical field personnel for the purpose of placing the control system in operation and making necessary adjustments to ensure optimum operation. Upon completion of the work and at a time designated by the Contracting Officer, furnish the services of a competent technician regularly employed by the Control Panel manufacturer for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction shall be for not less than one 8-hour working day.

3.3.2 *Plan for Instructing Operating Personnel*\

Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating personnel. This plan shall be tailored to suit the requirements of the Government. The training program shall provide:

a. a detailed overview of the control system
b. a general overview of Programmable Logic Controllers
c. the maintenance of equipment installed
d. the programming of the PLC
e. trouble shooting of the system

Complete approved Operation and Maintenance manuals for Specification 16906 and 16415 (specifically pertaining to the motor control center and it's relay ladder diagrams) shall be used for instructing operating personnel. Training shall include both classroom and hands-on field instruction. The class shall be video taped in the VHS format.

3.3.3 Field Inspection and Tests

Testing shall be coordinated with the overall Fueling System start-up test specified in specification section "SYSTEM START-UP, FUELING". Prior to this test, all field connections shall have been made and interconnection to the control panels. In addition, wiring shall have been checked for continuity and short circuits. Perform tests in such a way as to obtain information about the performance of the control panel and field devices. Tests shall be performed or supervised by competent employees of the system supplier. A fourteen day notice of testing shall be given to the Contracting Officer. If the Contracting Officer witnesses tests, such test shall be subject to approval. If the Contracting Officer does not witness tests, provide performance certification. Field inspection and tests shall be performed as stated in approved inspections and test plan.

3.4 *TOOLS AND SPARE PARTS*\

Any special tools necessary for maintenance of the equipment shall be furnished as well as one spare set of fuses of each type and size required, fifty percent spare lamps for each type of incandescent indicating light. In addition, the Contractor shall furnish a list of items recommended by the manufacturer to assure efficient operation for a period of 120 days at the installation. Include part number, current unit price, and source of supply. The Contractor shall also provide one spare power supply module, one I/O module (for discrete devices) in addition to the above requirements. Contractor shall provide 5 spare ventilation fan filters.